THE INSTITUTION OF PRODUCTION ENGINEERS JOURNAL

SEPTEMBER 1956

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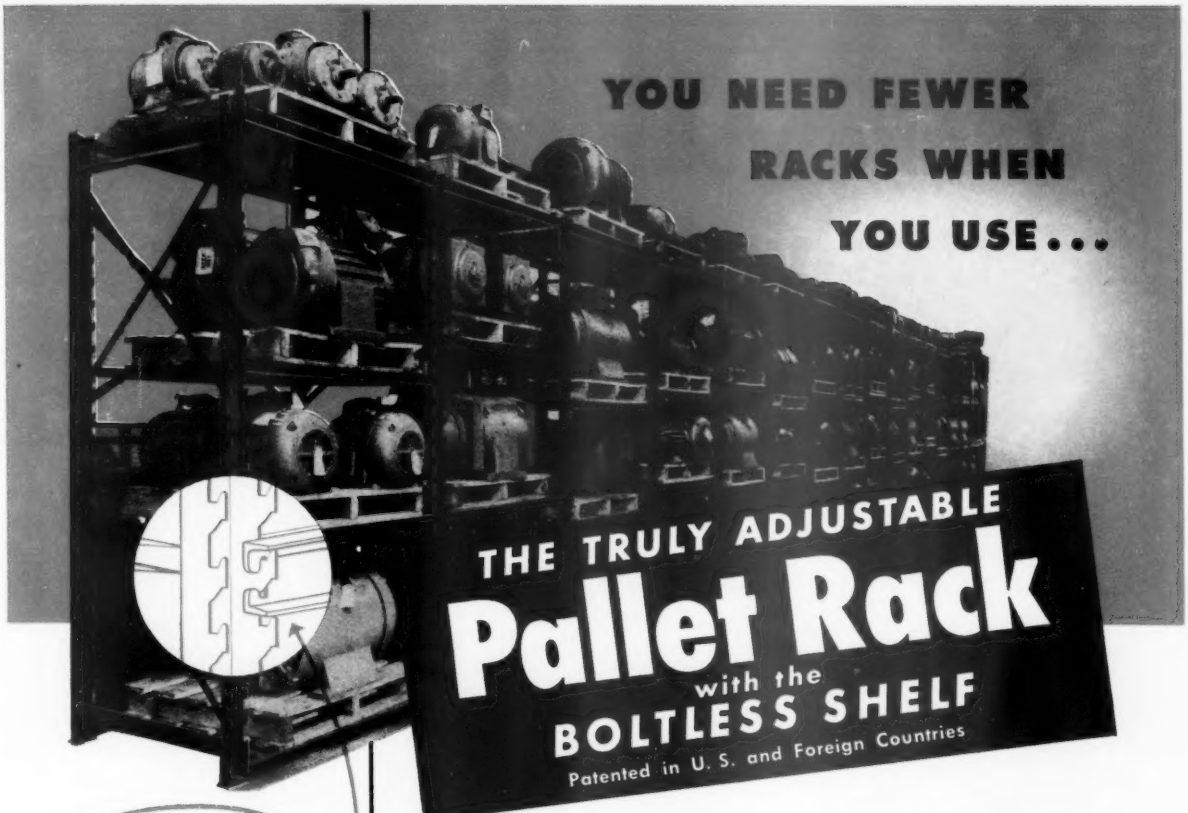

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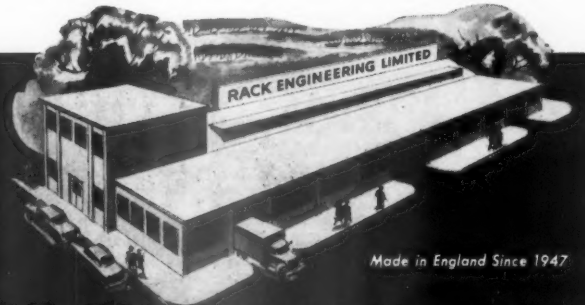

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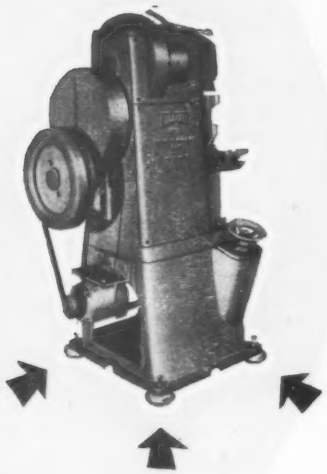

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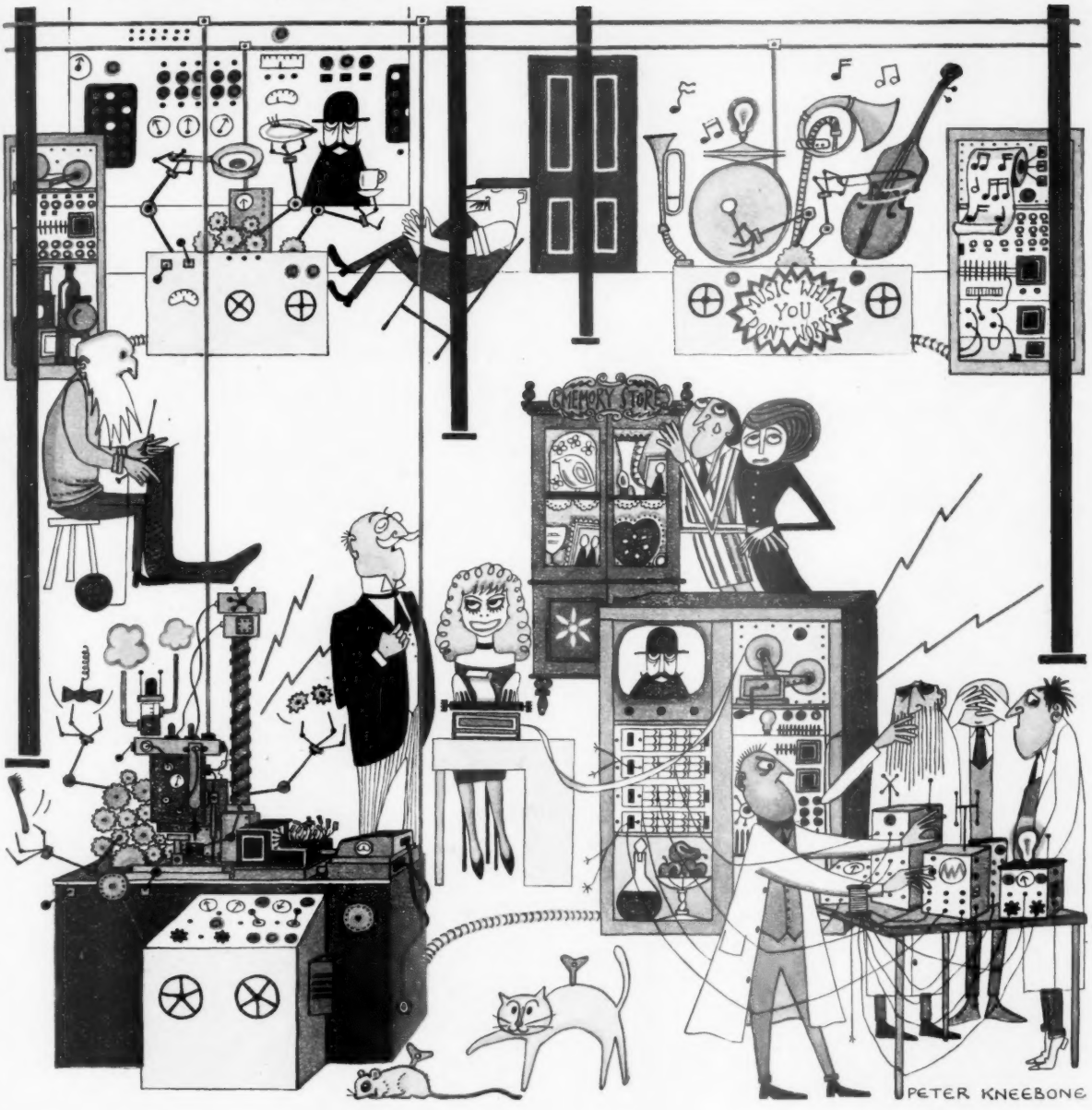

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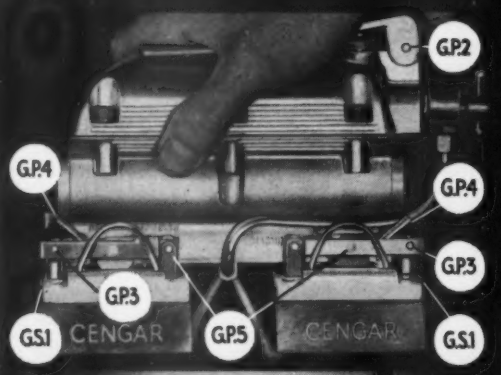

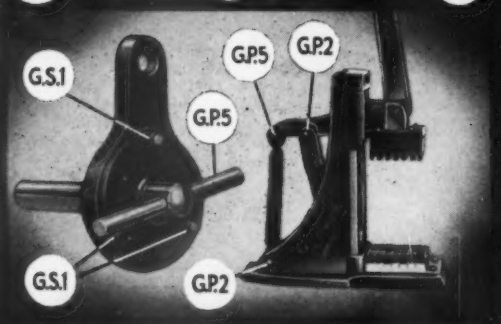

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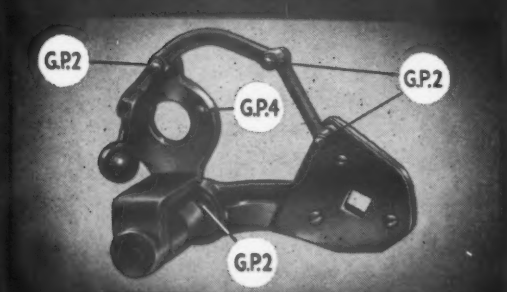

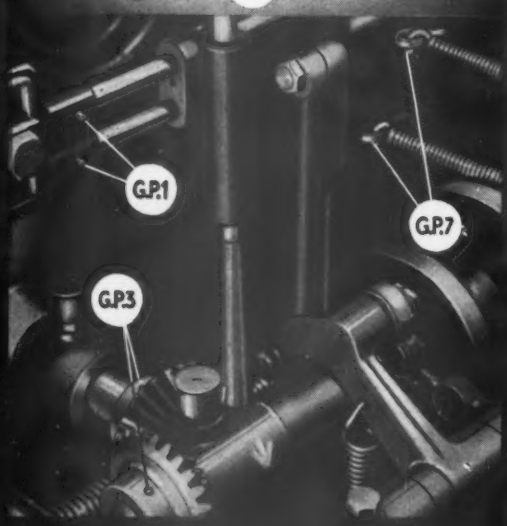

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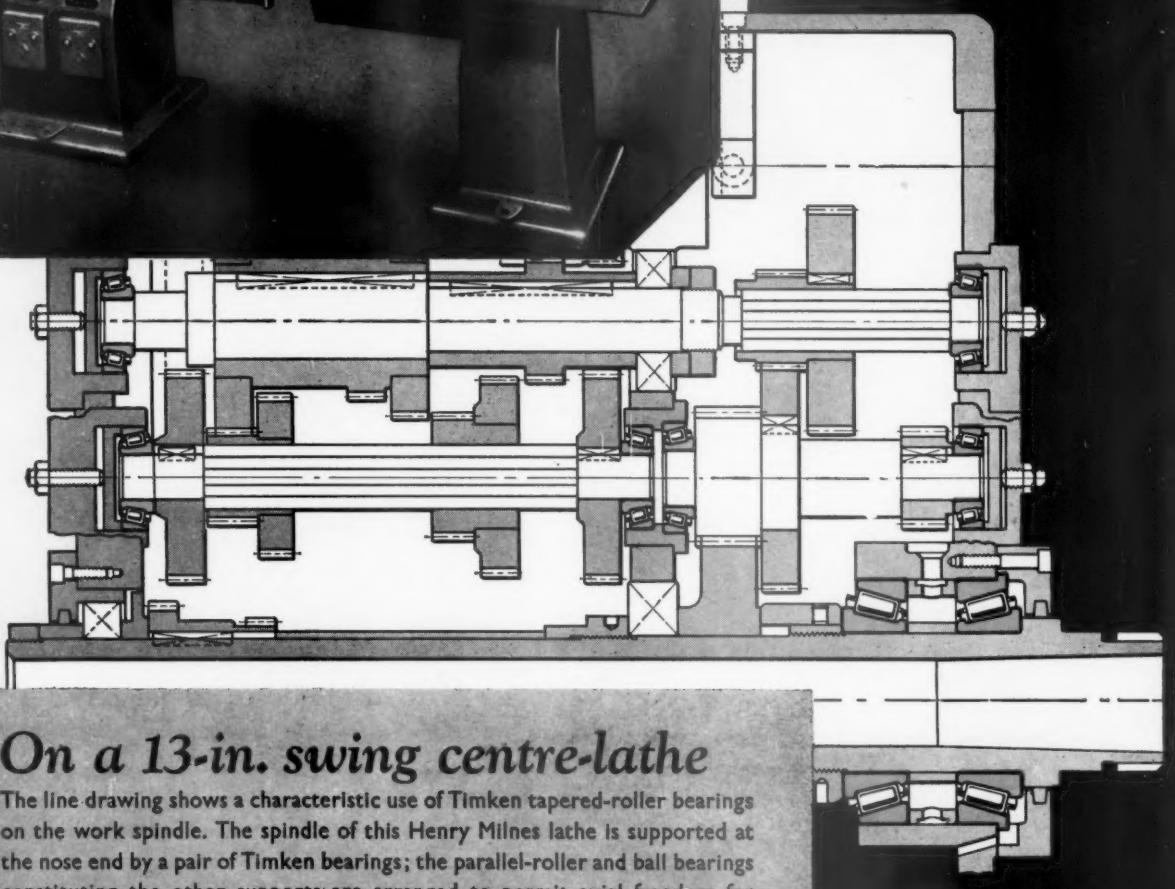

On a 13-in. swing centre-lathe

The line drawing shows a characteristic use of Timken tapered-roller bearings on the work spindle. The spindle of this Henry Milnes lathe is supported at the nose end by a pair of Timken bearings; the parallel-roller and ball bearings constituting the other supports are arranged to permit axial freedom for expansion and contraction. In this way the spindle is end-located close up to the work by the pair of Timken bearings and without possibility of disturbance of the pre-loading.

It will be noticed that the use of the Timken flanged bearing enables the housing to be bored for both bearings at the same setting, thus maintaining concentricity. The flange of the right hand bearing is clamped against the housing by the cover, and thus locates both bearings and thereby the spindle, and incidentally provides a register for the cover.

As will be seen, Timken bearings are also used on the driving shafts.

This and many other examples are illustrated in our machine tool manual, available on request.

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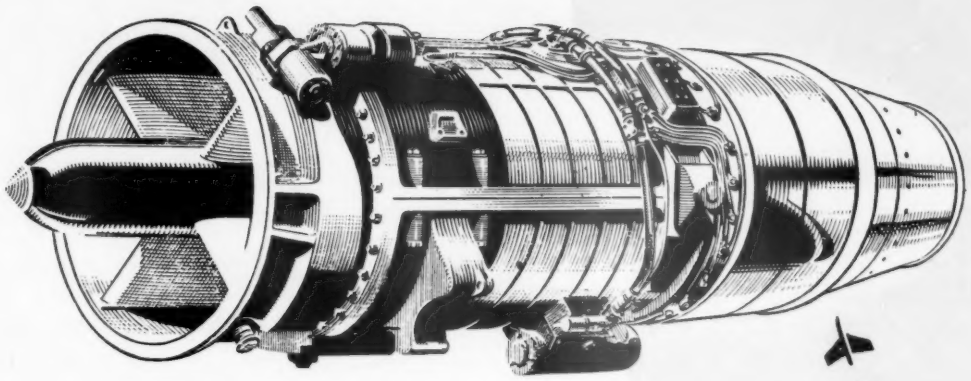

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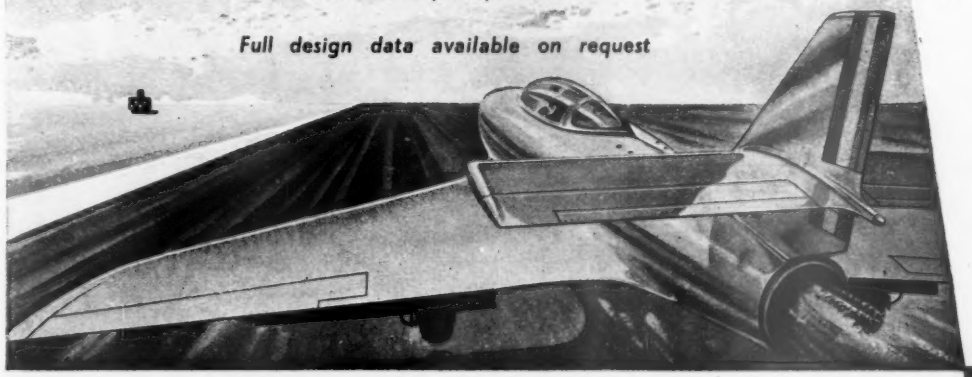

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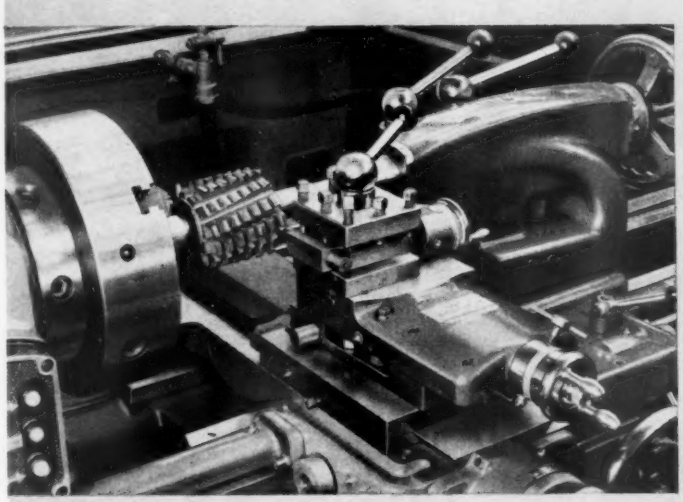

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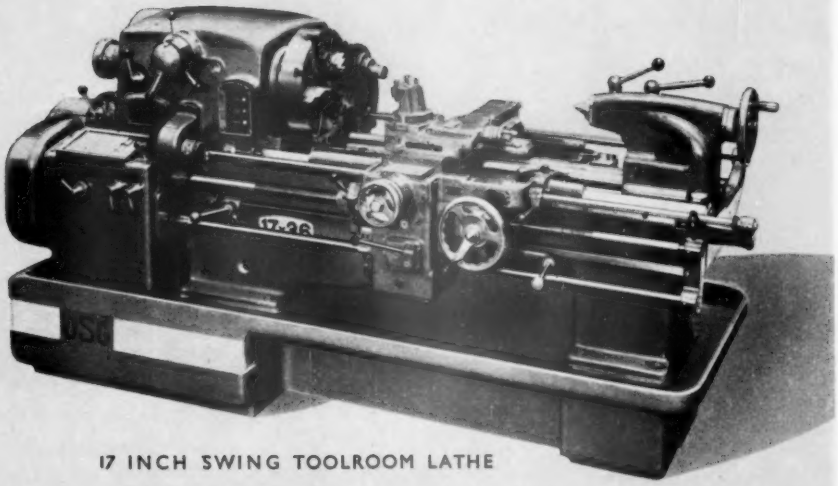

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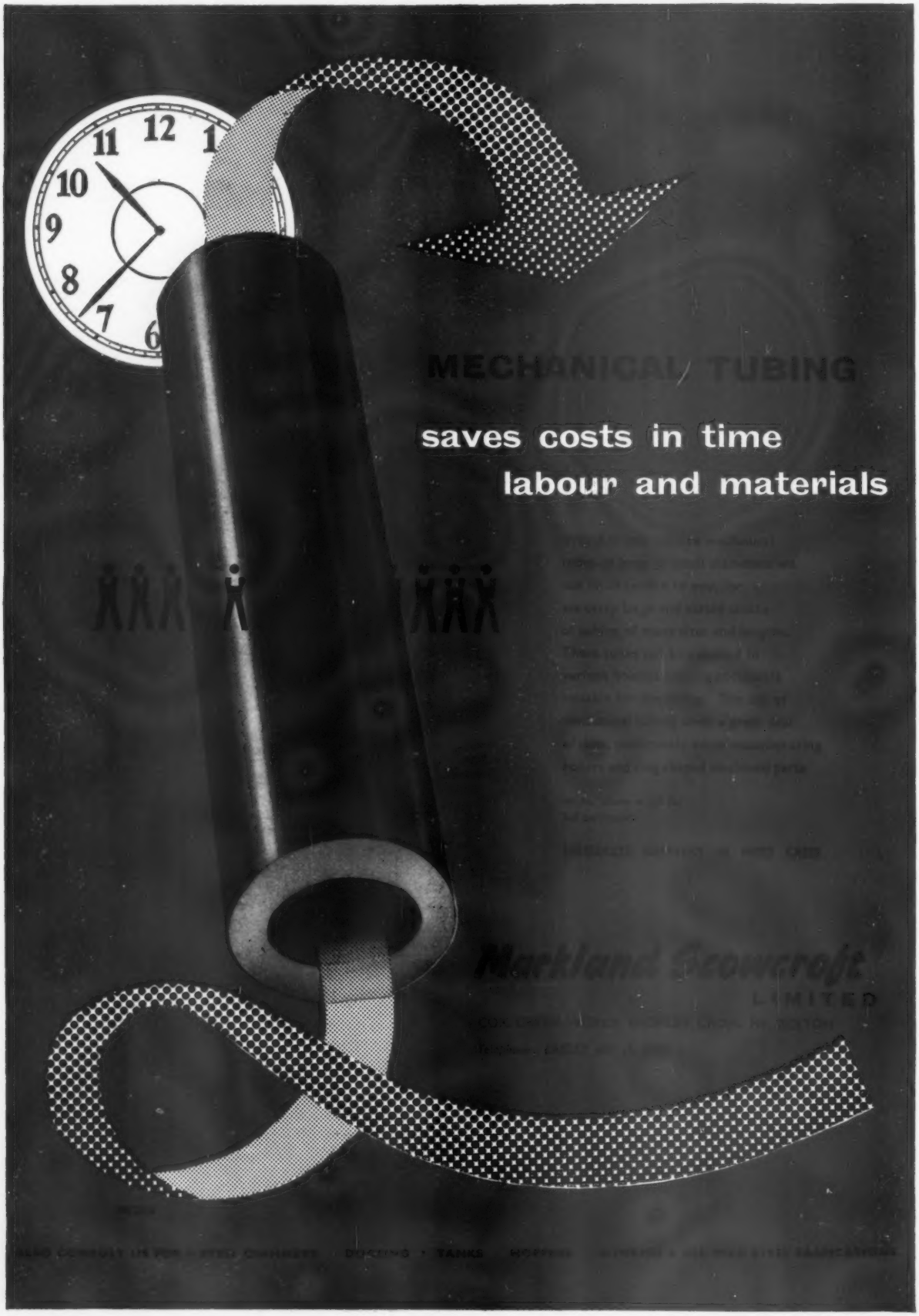
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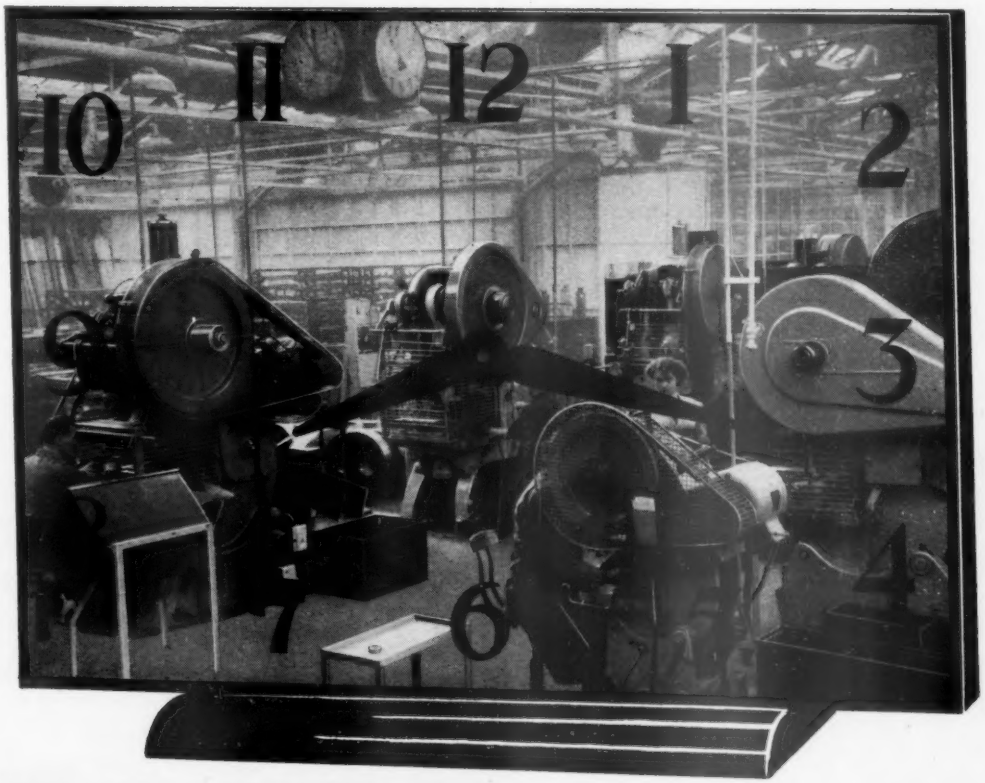

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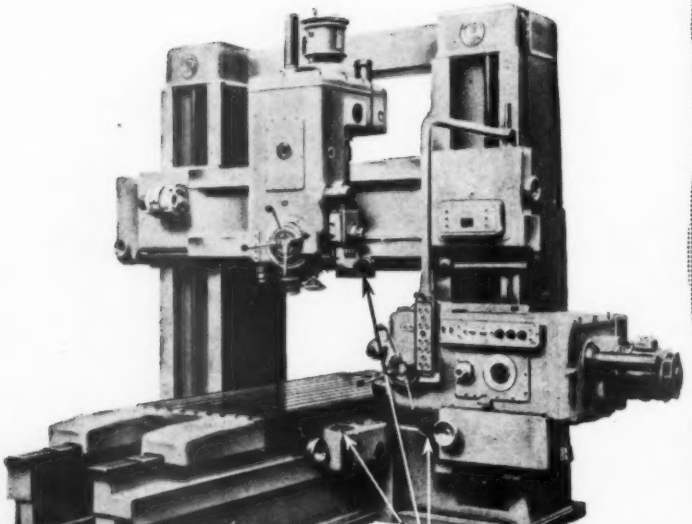

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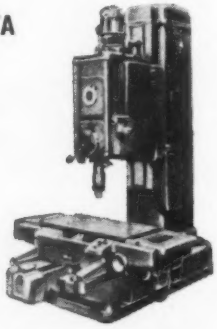
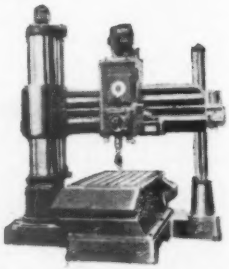


And for smaller work . . .

TYPE OPCO 65

Table Size 40" × 70"



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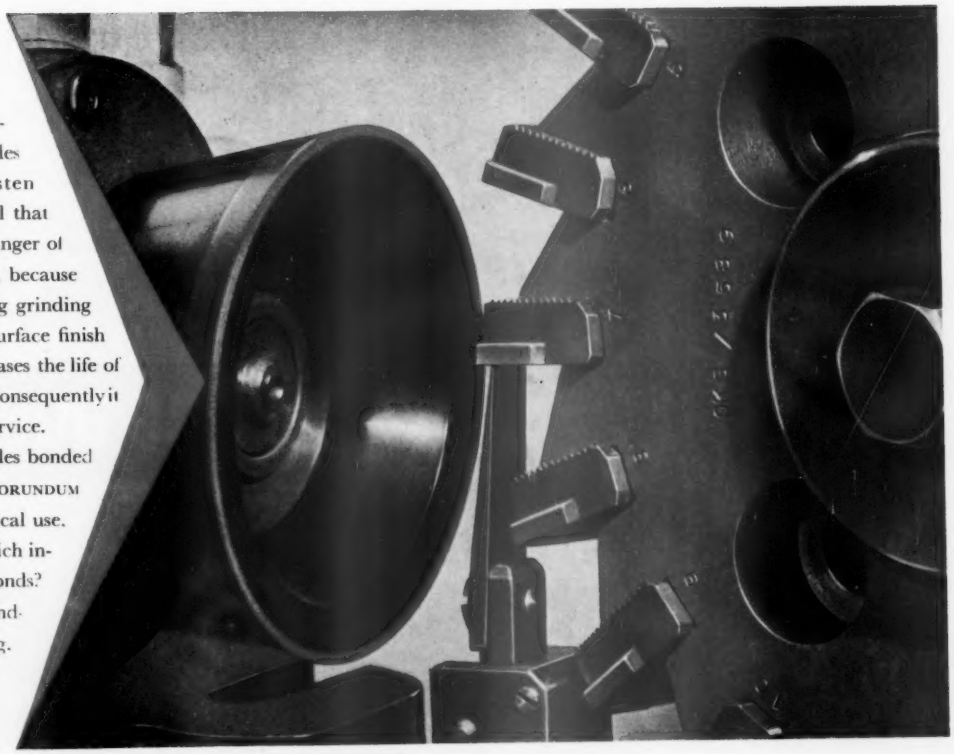

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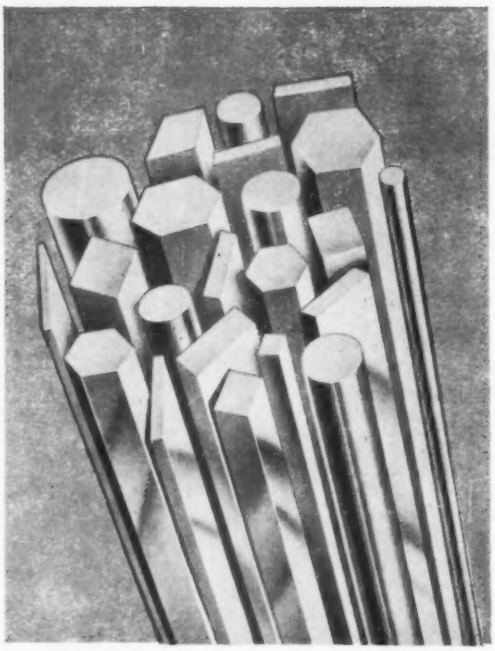

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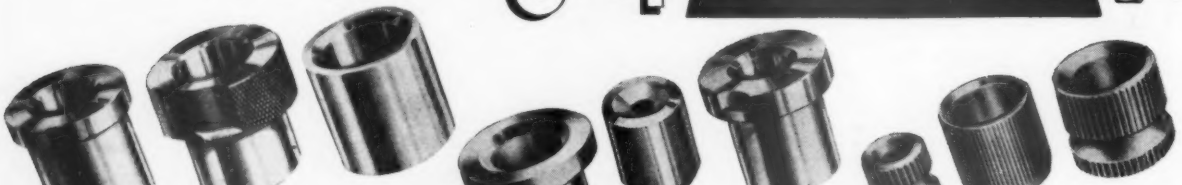

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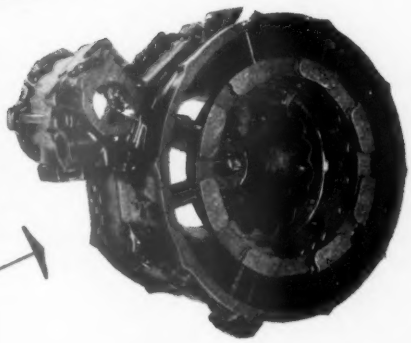
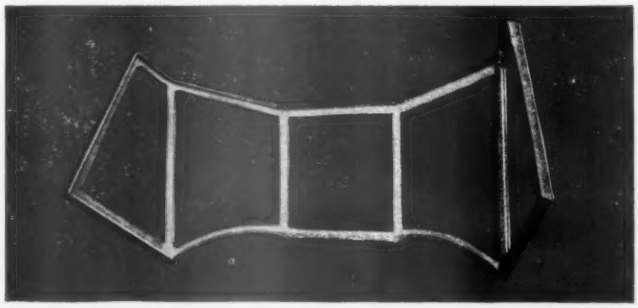
Z T 1 alloy
Main support plate of the "Eland" propeller turbine engine. This casting virtually forms the structural basis of the whole engine.
Courtesy:
D. Napier & Son, Ltd.
Sterling Metals, Ltd.



Z R E 1 alloy
Air-inlet casing of the "Dart" propeller turbine engine. There are 82 ZRE1 castings, total fully machined weight 225 lb., in this engine.
Courtesy: Rolls-Royce Ltd.



R 5 Z alloy
Windscreen frame of the "Rotordyne" helicopter.
Courtesy: The Fairey Aviation Co. Ltd.
Sterling Metals, Ltd.

Z 5 Z alloy Main wheel of the Vickers "Viscount" aircraft. The wheels of nearly all British aircraft designed in the last 8 years are made of this alloy.
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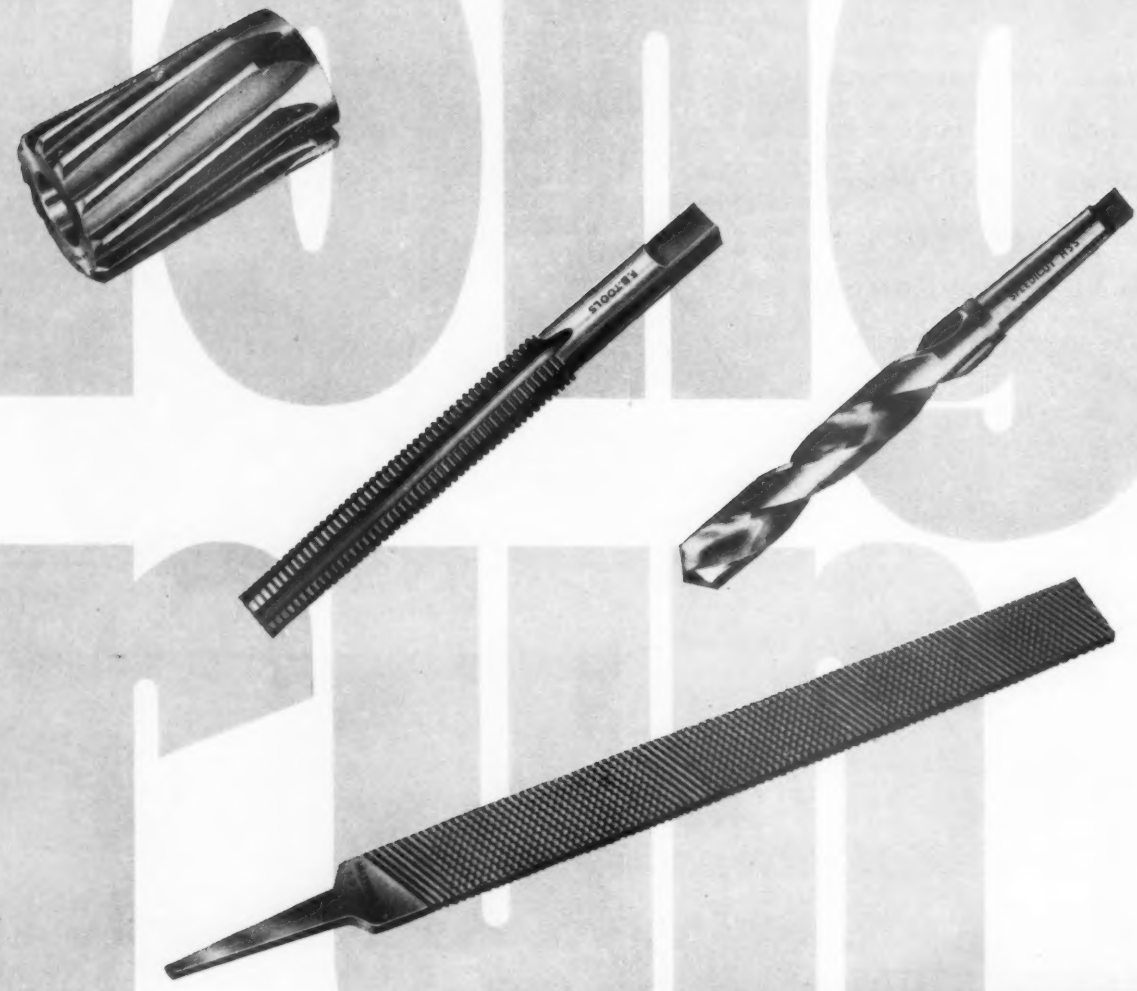

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F B T

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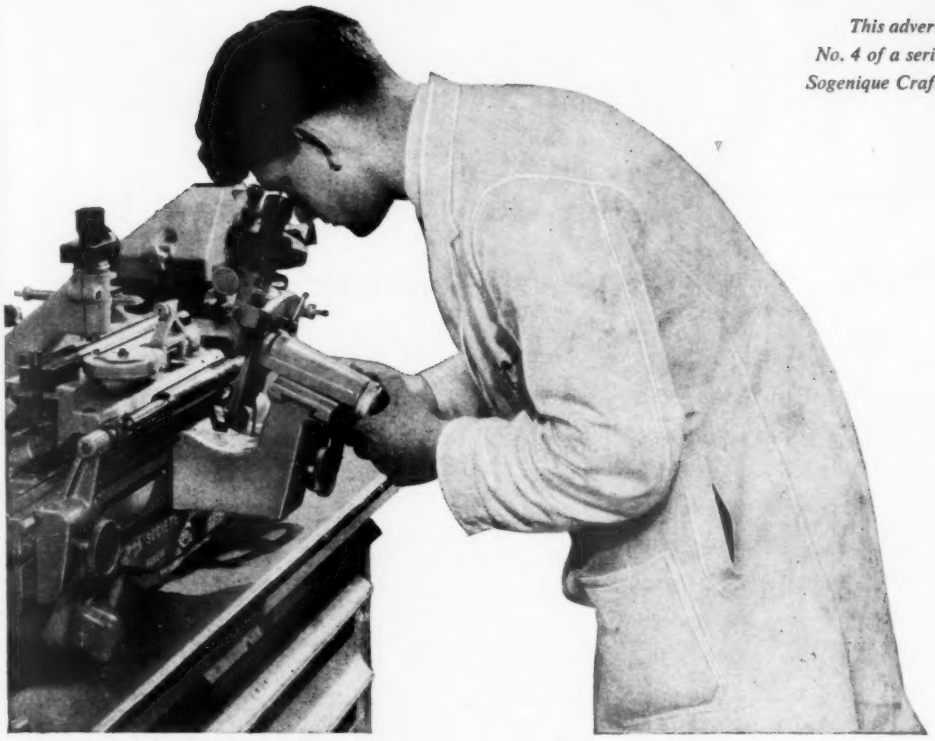

craftsmanship counts...

. . . and nowhere more so than in the maintenance of high precision machine tools. The care taken in the rebuilding and repair of worn parts has become a specialized skill in itself. The jig boring and milling machines manufactured by the Société Genevoise are serviced and maintained by the skilled and specially selected craftsmen of Sogenique (Service) Ltd.

In the illustration Mr. C. Muller is inspecting the form of a high-precision worm-shaft, an operation requiring a high degree of skill and knowledge to make full use of this precision tool. This is an example of the high standards which are the hall-mark of Sogenique Service. The installation and servicing of Société Genevoise jig boring and milling machines is carried out by such craftsmen, who also train personnel in their operation.

SIP

Sogenique (Service) Ltd

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3K essential features...

RIGIDITY · SPEED OF OPERATION · ACCURACY

These three features are incorporated in this medium-size machine for rapid precision boring. Rigidity is plainly visible in the planer-type design and rugged construction. Speed of operation is ensured by the GSIP indexing method and a wide range of spindle speeds and feeds. The built-in measuring screws eliminate the use of gauge blocks, dial indicators or micrometers and the tedious combination of these to make up the desired dimensions. For accuracy, direct-reading divided drums provide rapid and accurate placing of holes, the centre-distances of which are read to

0.00005 inch or 0.001 mm.

Extraordinarily versatile, this machine can be used for jig and tool work, die making, development work and direct production.

The installation and service of this machine is carried out by the Area Engineers of Sogenique (Service), Ltd., under the GSIP guarantee.

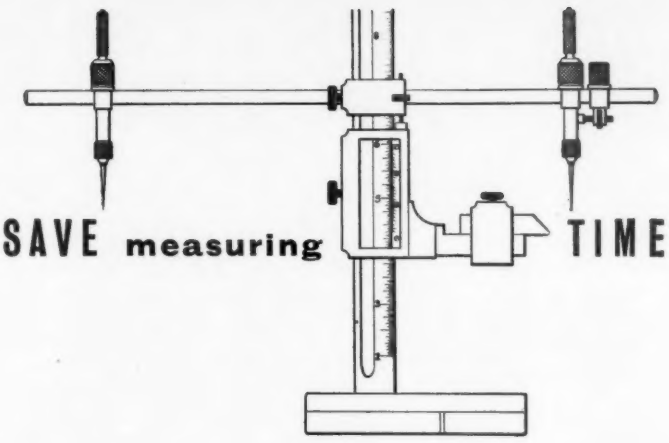
For literature or further information please write or telephone Temple Bar 2126.

MP-3K

Longitudinal travel of table	18 in.—450 mm.
Transverse travel of spindle saddle	14 in.—350 mm.
Distance from table top to spindle end max.	20½ in.—520 mm.
(retracted) min.	4½ in.—120 mm.
8 spindle speeds	75—125—210—340—480—770—1250—2000 rpm.
GUARANTEED ACCURACY FOR ALL DISPLACEMENTS OF THE WORK-TABLE AND SPINDLE SADDLE	0.00015 in.—0.004 mm.

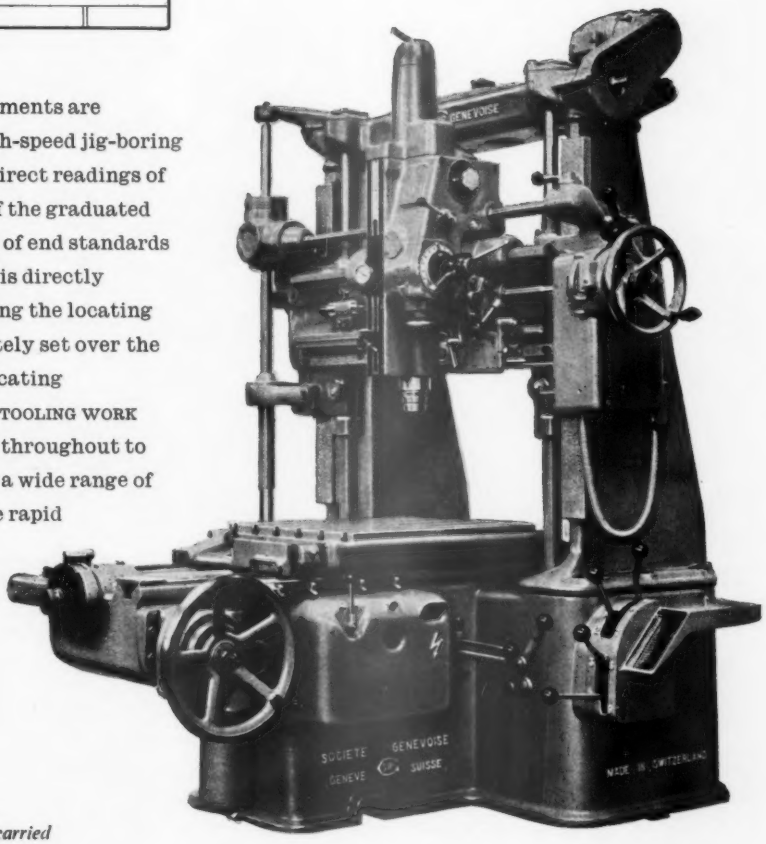
Société Genevoise Ltd

5-6 BRETTENHAM HOUSE · LANCASTER PLACE · LONDON W.C.2



SAVE measuring TIME

Even the most modern measuring instruments are unnecessary for machining with this high-speed jig-boring machine. Its micrometer heads permit direct readings of *0.00005 inch or 0.001 mm.* on the verniers of the graduated drums, and there is no need for selection of end standards or combining calipers and gauges. Work is directly mounted on the table and squared up using the locating indicator, the spindle then being accurately set over the origin of co-ordinates by means of the locating microscope. SAVING IN TIME AND COSTS FOR TOOLING WORK RANGE FROM 60 TO 80%. Substantially built throughout to withstand heavy duty, this machine has a wide range of speeds and automatic feeds which ensure rapid operation on various types of work.



MP-4G

The installation and service of this machine is carried out by the Area Engineers of Sogenique (Service) Ltd., under the GSIP guarantee.
For literature or further information please write or telephone Temple Bar 2126.

Longitudinal travel of table .. .. .. 24 in. — 600 mm.
Transverse travel of spindle saddle .. 20 in. — 500 mm.
Distance from table top to spindle end max. 25 in. — 635 mm.
min. 5 in. — 120 mm.
20 spindle speeds 50 — 60 — 70 — 85 — 110 — 130 — 150 — 185 — 230 — 280 — 350 — 425 — 480 — 600 — 750 — 920 — 1065 — 1300 — 1630 — 2000 rpm.

GUARANTEED ACCURACY FOR ALL DISPLACEMENTS OF THE WORK-TABLE AND SPINDLE SADDLE *0.0002 in. — 0.005 mm.*

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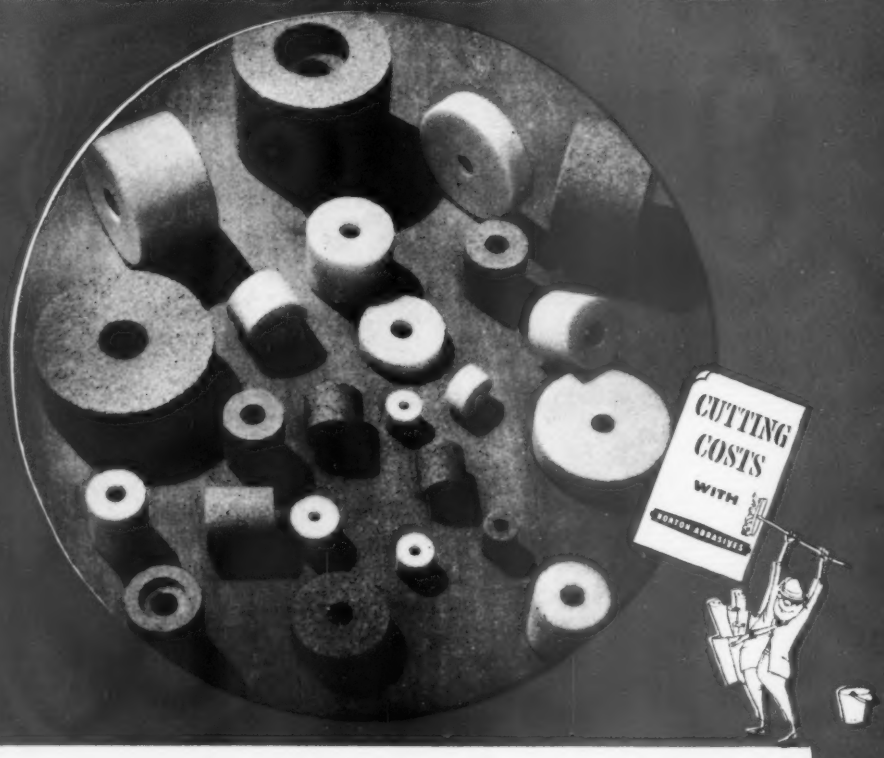
PRECISION MOULDED Norton Wheels cut INTERNAL GRINDING costs !



The precision moulding of grinding wheels, a process developed by Norton engineers, ensures the utmost accuracy in measuring and weighing the "mix". All Norton Internal Grinding Wheels are now precision moulded. The result? . . . *every* wheel of the same specification can be relied upon to give identical grinding action. And because you can depend upon this consistent top-line performance, you can save precious time between wheel changes—time saved for getting on with the job!

Here's more good news. Norton Internal Alundum Wheels are now available in G BOND. This means faster, cooler cutting, better shape holding and less dressing. It means Internal Wheels that last longer and produce a better finish, for those are the qualities which G Bond imparts.

What a combination! To prove the cost cutting qualities of these new Norton Internal Wheels arrange for test runs with your Norton or Alfred Herbert Representative the very next time he calls—or write to us.

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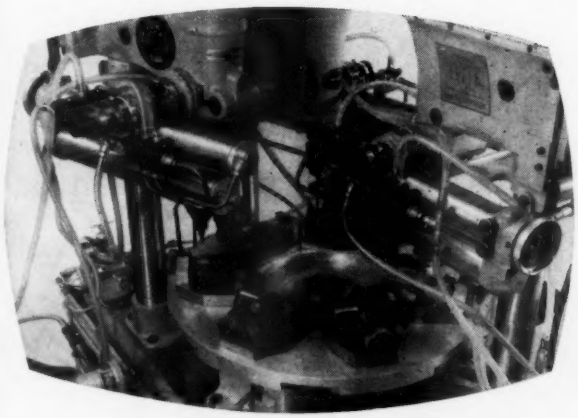
Welwyn Garden City, Herts. *Enquiries also to* ALFRED HERBERT LIMITED, COVENTRY

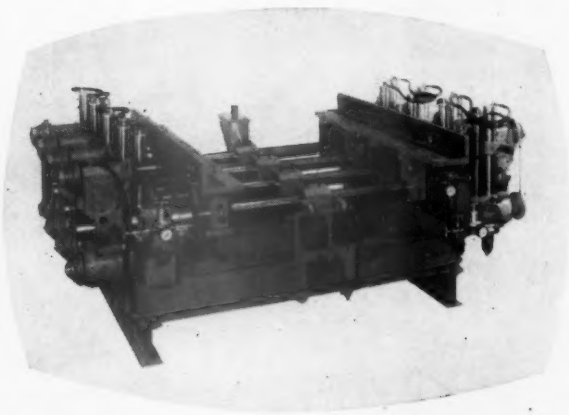
NORTON ABRASIVES

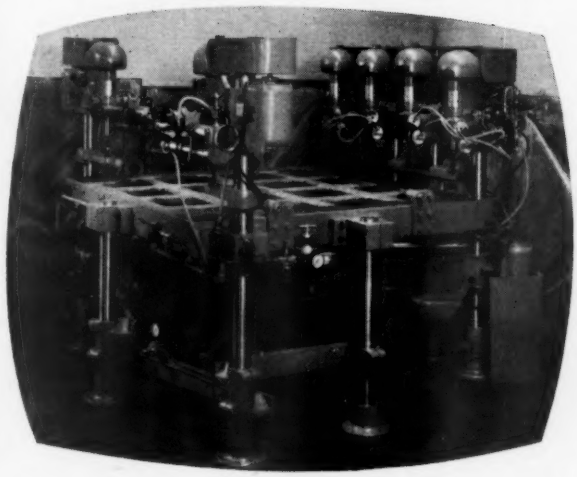
NGW3W/103

AIRMATION

means automation by compressed air. And it means production *up* and costs *down!* Some examples of AIRMATION are shown where MAXAM control valves, cylinders etc., are used for moving, clamping and sequence control on special purpose machines designed and made by PACERA (W. J. Meddings Ltd.), by whose kind permission the illustrations appear. Can our Technical Staff help *you* with AIRMATION?







- ***Above right:*** A machine for drilling 16 holes in a 54 in. x 52 in. component. 8 heads at 12 in. centres operate simultaneously. Component is automatically moved to next station and the operation repeated, leaving 16 holes at 6 in. centres. Floor to floor time 47 seconds; previously, the operation required 15 mins. 10 secs.

- ***Above left:*** Progressive drilling followed by tapping on a special Hammer Head. Three operations performed simultaneously and in sequence with automatic table indexing. Floor to floor time 33 seconds; previously, the operation required 2 mins. 15 secs.

- ***Below left:*** A machine for drilling 18 holes in a 54 in. x 52 in. component. Firstly 8 heads directly opposed at 6 in. centres operate simultaneously. The component is rotated through 90 deg. when 10 heads again operate to complete. Floor to floor time 47 seconds; previously, the operation required 15 mins. 10 secs.

AIRMATION BY MAXAM

Airmation means automation by compressed air and is a Registered Trade Mark.

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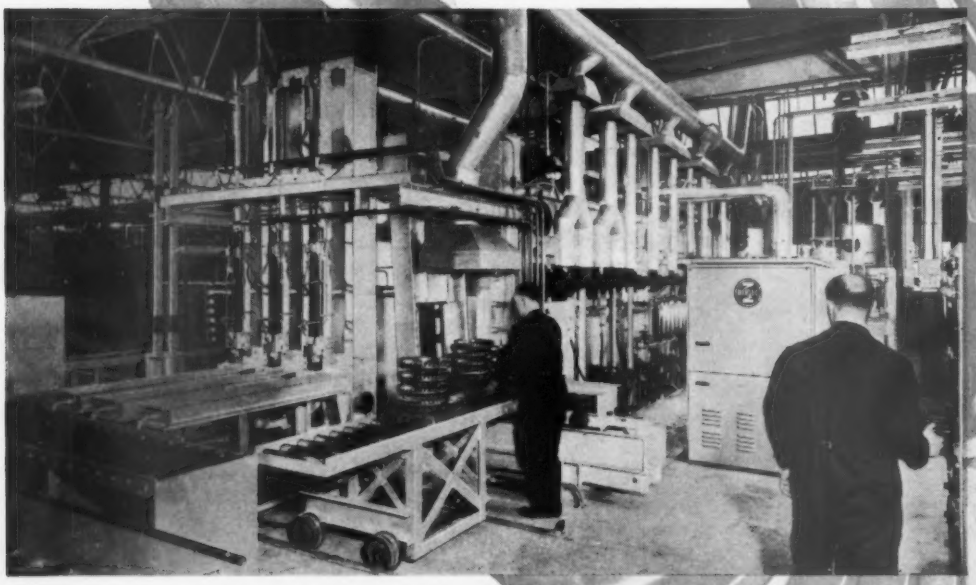

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Illustration shows 'dag' colloidal graphite being applied to the dies of a 2,000 ton horizontal extrusion press.

(photograph by courtesy of The Yorkshire Copper Works Ltd.)

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Sizes	No. 5. Plain	No. 5. Univ.	No. 5. Vert.	No. 6. Plain	No. 6. Vert.
TABLE	94½" x 20"	94½" x 20"	94½" x 20"	104½" x 20"	104½" x 20"
RANGES					
Longitudinal	50"	32"	50"	60"	60"
Cross	14"	14"	18"	14"	18"
Vertical	20"	19"	20"	20"	20"
Vert. Head	—	—	8½"	—	8½"
SPEEDS - r.p.m.	14-1,400	14-1,400	14-1,400	14-1,400	14-1,400
FEEDS-in./min.	⅜"-90"	⅜"-90"	⅜"-90"	⅜"-90"	⅜"-90"
DRIVE					
Spindle-h.p.	40-20*	20	40-20*	40-20*	40-20*
Table-h.p.	5	5	5	5	5
WEIGHT - lbs.	12,700	13,700	14,500	13,000	14,000

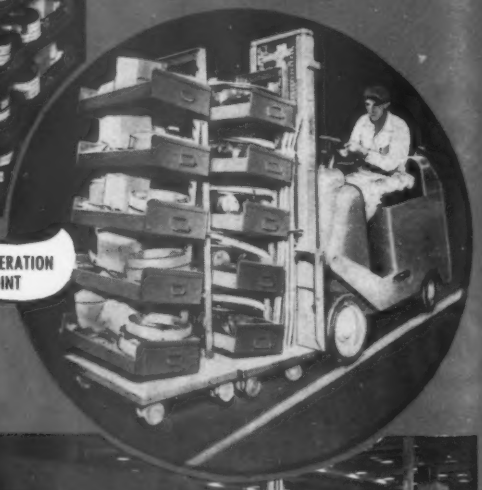
*40 h.p. at high speeds ; 20 h.p. at slow speeds (or 20 h.p. at all speeds, if preferred)

CINCINNATI MILLING MACHINES LIMITED BIRMINGHAM 24

RACK CONVEYORS saved 1235 man-hours per month!

...and paid for themselves in 60 DAYS

Typical of many RACK installations throughout industry



CONTROLLED MATERIALS PLACEMENT *helps speed Assembly and Machining*

THE movement of sets of related parts, step by step, from stock room to point of final assembly, by Rack Conveyors, is shown in these pictures. Note that the material is sorted and placed on Rack Conveyors in workable order, creating a portable bank for servicing operation points.

Thus *controlled materials placement* avoids loss of time and confusion and helps speed production!

Write for information on Rack Conveyors for your particular shop procedure, whether for handling, moving or processing.

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Rack CONVEYOR SYSTEMS

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Bantam CUTS OVER
57 MILES OF STEEL
–WITH ONE NOZZLE
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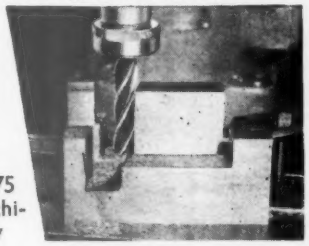
UNBRAKO SOCKET SCREW CO., LTD., COVENTRY

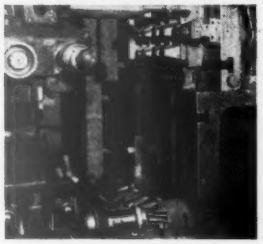
the finest cutting teeth in the business!

THE FEEDS AND SPEEDS GIVEN HERE ARE OBTAINABLE ON NORMAL PRODUCTION RUNS . . . . . .



Long Series End Mill taking $\frac{1}{16}$" deep cut on $1\frac{3}{4}$" face with hand feed 275 r.p.m. $\frac{5}{8}$"-long Series Autolock Cutter machining a drill jig gives this customer accuracy with certainty, and no risk of the cutter spoiling an expensive workpiece.

sheat cutting!



Clarkson Autolock copy form milling for a mould for fibre egg containers. The rigidity of the Autolock chuck is often the only solution for this type of work, with varying loads on the cutter.

Autolock Slot Drill, $\frac{1}{4}$" milling slots in tough steel, 466 r.p.m., $\frac{5}{8}$" per minute feed. Only Autolock cutters can give long life between regrinds when working under difficult conditions like this.

more examples in future issues!

You buy Clarkson cutters at MAKERS PRICES!

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If you want to know something about

BORING & TURNING MILLS...

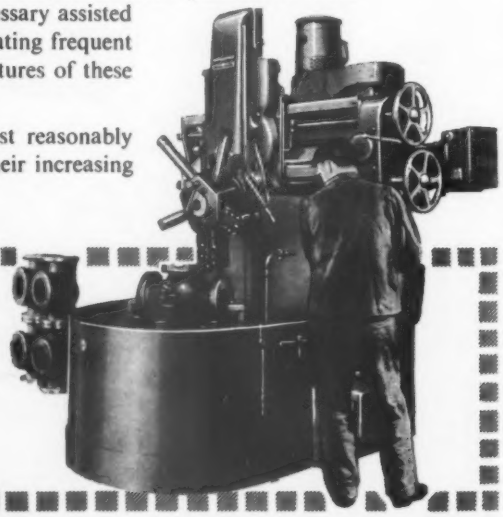
SEE YOUR COMPETITORS!

If your business requires the boring and turning of medium to large castings and forgings or similar components, and you do not use Webster and Bennett Boring Mills, it's highly probable your competitors do.

In that case, they'll be getting the benefit of lower overheads, because on the bases of capital costs and running costs there are no other machines quite as economical.

Powered for carbide tooling and high metal removal rates; centralised hydraulic controls for operating convenience; easy reservicing when necessary assisted by unit construction; self-compensating clutches obviating frequent adjustment for wear, are some of the outstanding features of these machines.

Add to this the fact that they are probably the most reasonably priced machines of their kind, and the reasons for their increasing demand become clear.



The illustration shows one of the battery of Webster and Bennett Boring Mills installed in the London Works of Dewrance & Co. Ltd., facing, turning, boring and screwing 5" valve bodies in a floor to floor time of 66 minutes.

WEBSTER & BENNETT LTD., COVENTRY, ENGLAND

LOOK! THE NEW IMPROVED FULLY-AUTOMATIC

Lincolnweld

FOR SPEEDIER AND EASIER SUBMERGED-ARC WELDING

The control box position gives better speed range changing and is fitted with full-scale reading Ammeters and Voltmeters (voltmeters 0-60V., ammeters 0-800 or 0-1500, complete with shunt). The new position of the hand control box improves visibility and control.

ALWAYS IN THE LEAD Lincoln Electric have made improvements to their 'Lincolnweld' submerged-arc welding equipment which will cut costs, speed production and produce a better quality weld.

The new 'Lincolnweld' is specially strengthened to avoid whip. Rollers are fitted on the travel carriage to ensure lateral stability. A double slide is fixed to the strengthened travel carriage which allows vertical movement up and down of 6″ and horizontal movement through 4½″. The wire feed gear-box, control-box and hopper can be rotated through 90° to cope with circumferential seams.

A new feature is the adjustable spot light which helps the operator to see the welding point. The arrowpoint light is operated from 115V DC at 12V through a variable resistor.

The new position of the wire reel carrying stand gives better weight distribution and improves the feeding to the drive rolls and welding nozzle. A special hand adjusted wire straightener ensures that the wire is straight as it leaves the nozzle. The rollers are suitable for either single or twin arc welding.

On the flux hopper a Flap valve replaces the quadrant valve enabling solenoid control to be applied to the flux feed. The new flux tube nozzle design is streamlined and circular in section. Two types can be fitted, type A. is suitable for Lincolnweld wire $\frac{5}{64}$″ to $\frac{1}{8}$″, type B. for Lincolnweld wire $\frac{3}{32}$″ to $\frac{7}{32}$″. A flux retainer can be fitted round the nozzle to ensure retention of correct volume of flux at the welding point. The flux-feed tube from hopper to retainer is made from a corrugated tube to give greater flexibility.

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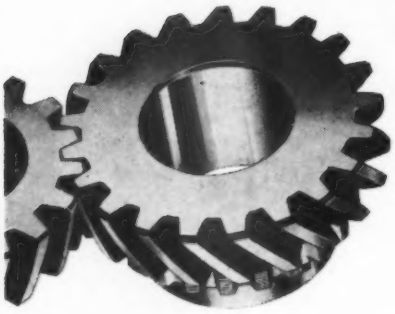
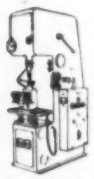
HONING

MAKES RUNNING PARTS RUN BETTER

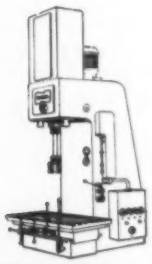


Nagel Horizontal Honing Machine. Capacity from ¼" to 2½" dia. bores.

Nagel Brake Drum Superfinishing Machine. Automatic work cycle with hydraulic clamping.



Nagel VM Type High Duty Machine especially suitable for hard-chromed components.



Nagel Long Stroke Honing Machine. Strokes from 24" to 48" with capacity from 1¾" to 20" dia. bores.

Honing of close-limit components eliminates heavy initial wear, and allows closer tolerances, thus increasing considerably the reliability and performance of all classes of product on which honing is used.

Superfinishing of internal and external surfaces can be carried out on a mass-production basis using Nagel Honing Machines—with the added advantage of automatic cycle operation on certain machines.

Mass production of honed components to the highest limits of accuracy can be obtained by using the Nagel Automatic Cycle double-spindle machine complete with Special Nagel Sizing Equipment.

A high level of production is also possible, however, with the push-button controlled single spindle machines which incorporate the special Nagel features of infinitely variable hydraulic operation of all movements of the machine, including tool adjustment and speed.

A leaflet is available from :—

WICKMAN LIMITED

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The Institution of Production Engineers Journal
VOL. 35 NO. 9 SEPTEMBER, 1956

The Challenge of the Age

by E. W. HANCOCK, M.B.E.,
President of the Institution.

NEVER before in the history of the world has mankind been presented with such apparent opportunities as stand before him today. Among all social groups, Production Engineers have a unique place, in that it is through their efforts in the field of industrial manufacture that they can make readily available to the generality of people the benefits of the phenomenal technological advances which crown the work of our scientists. Above all others, the Production Engineer has the opportunity to transform the results of research and development into real benefits for all to enjoy. His position in industry is unique in the sense that he is the vital link between the boardroom and the shop floor; between designer and consumer. He is the key point to higher productivity and, with it, a better standard of living for all. At the same time, he has a personal responsibility for ensuring good human relations — without which no manufacturing enterprise can prosper.

His position is therefore an exacting one and must cover a wide range of skills and human attributes: the good Production Engineer must be at once manager, technologist, planner, diplomatist and mediator. The importance of the Production Engineer in industry today cannot be over-emphasised and it must not be forgotten that the demands of increased competition in world markets and of far-reaching new developments and processes will tax still further the minds of Production Engineers in the future.

A Heavy Responsibility

The very nature of the Production Engineer in industry — be he called Managing Director, Works Manager or any other title you will — imposes upon him considerable responsibilities. He must carry on his shoulders a responsibility both to his own manufacturing enterprise and to the community at large by ensuring that the benefits of higher productivity are shared all round — by consumer, employee and employer. It is a heavy responsibility.

However, the position of the Production Engineer in industry also lays before him numerous opportunities. They are there for him to seize, if and when he will. To me the opportunities of the present and of the future must be a challenge to all Production Engineers and one which I most sincerely hope will be accepted by all members of our Institution, whatever their age, or position on the ladder of success. It is a challenge which we must accept for if we do not, then other countries will, and we shall all be the poorer for it. The future is there for us, waiting. We, as Production Engineers, must see that we are not found wanting.

What does this challenge involve?

To my mind we must know our responsibilities, both to industry and to the community. In the years to come the Production Engineer will require a greater knowledge of science and technology than ever before. It is our first duty, therefore, to see that our young men are given the right training and to see that first-class brains are directed into this all-important profession of production engineering.

Obviously if we are going to obtain the most benefit from new materials and machines we must look to the future and see that our youth is equipped to exploit these new developments to the full. Are we making sure that our young men are getting the right training? Personally I feel that this is one of the 'blind spots' of our industry. At a time when there is a demand in Great Britain for at least 25% more technicians and craftsmen than at present, the figures show that only 21.5% of our youth between the ages of 15 - 18 years are undergoing systematic training for industry. (1954). A similar investigation in Germany shows that 63% of those young men and women between the ages of 15-18 are undergoing systematic training. Comparisons with U.S.A. and Russia confirm that we are lagging behind in our education and training programmes.

It is pleasing to note that the Ministry of Education is alive to the problem. Only recently the Prime Minister said :

> "The prizes will not go to the countries with the largest population. Those with the best systems of education will win. Science and technical skill give a dozen men the power to do as much as thousands did fifty years ago. Our scientists are doing brilliant work. But if we are to make full use of what we are learning, we shall need many more scientists, engineers and technicians. I am determined that this shortage shall be made good . ."

Industry must, on its own account, be urged to set up an increased training programme and to take a greater interest in the work of technical colleges. Firms should be encouraged to allow senior technical staff time during the day to lecture in technical colleges and universities.

Far Reaching Changes

For those of us who have long finished our class-room days, we have a duty to ourselves and to our fellows to see that our own education is continued, in the sense that our minds are kept open and receptive towards new ideas. It can truly be said that we are in an age of change : new processes, new developments — indeed, new sciences — have evolved in the last decade or two. The scientists of the world, the mathematicians, the technologists, are harnessing power in all its forms in the service of mankind, and this progress or development will continue. We are on the threshold of still more far-reaching changes.

It is the Production Engineer's job to see that he keeps himself abreast of these great technological advances; to examine and to adapt them to his own circumstances. The Institution's Journal is a fine medium for this; the meetings and conferences at Section and National level also provide an excellent forum for the exchange of ideas. However, this is still not enough and the Production Engineer must be continually watchful and at all times ready to try something new.

The challenge also demands something more than an understanding of the latest technological developments : it requires of the Production Engineer a mind which is ever alive to the human problems which arise from those developments. It is absolutely essential for him to have a closer knowledge of the basic effects of these changes, not only on groups of people but on the individual. Even if — in his individual and perhaps sometimes narrow conception — he cannot always understand the cause, he should apply his intelligence to the study of the effect.

Change is often met with suspicion and resentment. On the other hand, vast changes have been introduced with the minimum of disruption when the introduction of the innovation has been handled skilfully and with thought for the individual. This is something which the Production Engineer is admirably fitted to do. By analysing and understanding the fears for the future he is equipping himself to transmit his knowledge of automation and its implications to those whom it will affect, so that they will regard it without fear and suspicion. By such means as overlap planning, due consideration to time factors involved, flexibility of thought and action at all times, the Production Engineer can avert many of the problems inherent in the introduction of automatic devices.

False Conceptions

Automation is a word which — largely through the popular press — has become a bogey and, as members of this Institution, it is our duty to destroy the false conceptions which have been seeded in people's minds. At our Conference at Margate last year we tried to find out what it was all about. I think that we succeeded : some very straight thinking and talking was done and the published proceedings of that Conference have been accepted as an authoritative guide with a world-wide circulation.

Automation can be a great boon and a blessing to mankind. Why should we not harness the great forces available and apply them to serve the needs, health and comfort of all?

There are people who say there is nothing new in automation. This, I feel, is a mistaken view for we are constantly finding new applications. It is here that the Production Engineer can use his knowledge and skill. By continually extending the field of application of devices to aid production, he is contributing to the welfare of state and society. Improved productivity is the only way to a good standard of life; therefore, there must be no holding back or restrictions on the use of any modern devices which will help us to maintain and improve our standard of life.

As I see it, therefore, the challenge of the age to Production Engineers is fourfold :-

(*continued on page* 602)

The Production Exhibition and Conference

Olympia, London

23rd/31st May, 1956

The sixteen Papers presented to the Production Conference have been published in the Journal, commencing with the June issue. The four Papers which appear in this issue complete the publication. They are:

SESSION XIII, 30th MAY

"Investing in Better Materials Handling" by K. Trickett, B.Sc.(Eng.).

SESSION XIV, 30th MAY

"Investing in Better Utilisation of Resources" by Bertram White, B.Sc., F.R.I.C.

SESSION XV, 31st MAY

"Investing in Education and Training" by A. D. Bonham Carter.

SESSION XVI, 31st MAY

"Investing in Better Human Relations" by Fred Hayday, T.U.C.

A report of the Conference, including the opening and closing addresses, in addition to the Papers presented, will shortly be available from the Head Office of the Institution, 10, Chesterfield Street, London, W.1, price 30/- per copy.

SESSION XIII

INVESTING IN BETTER MATERIALS HANDLING

by K. TRICKETT, B.Sc.(Eng.), A.M.I.Mech.E.

Mr. Trickett

A Spencer Scholar of Coventry Technical College, Mr. Trickett graduated at the University of Birmingham with a first-class honours degree in electrical engineering. He served his apprenticeship at the B.T.H. Co. Ltd., and after completing his University studies joined the research staff of Joseph Lucas & Co. He later joined Welwyn Electrical Laboratories on the formation of that Company in 1937 *as Works Manager and Chief Engineer and in* 1940 *took an appointment with Production-Engineering Limited, a firm of industrial management consultants. Mr. Trickett is at present Southern Area Manager for Production-Engineering and is also a Director of an associated firm of technical engineering consultants, Combined Technical Services Ltd.*

A LARGE number of Papers have been written and a great deal has been said over the past ten years on the subject of materials handling, and it is interesting first to consider why the subject should have become so important. There are probably two main reasons :-

1. The continual improvement and mechanisation of 'direct' operations and the consequent reduction in direct costs has rapidly increased the proportion of material handling cost in the total production expense.
2. With improved standards of education, workers are becoming more and more reluctant to undertake jobs which involve a high degree of physical effort and which are relatively unskilled.

The continuing relative decrease in the direct labour cost per unit of production means that the volume of total production is increasing and, indeed, national statistics show that the productivity index has risen by 40% since 1948. Whilst many new factories have been built, much of this increase in volume has resulted from process improvements in old-established premises, and in such cases the greater volume of throughput has thrown up acute problems in the matter of receiving and despatch bay facilities and storage and transport within the plant. That these problems are being, and have had to be, faced is shown by the rise in the annual sales of handling equipment in this country. Compared with a productivity increment of 40%, sales of handling equipment, after correction for inflation, have risen by 58% since 1948.

Even so, and until recently, the handling of materials has often been regarded merely as an inevitable part of the work of all departments and has not been isolated as a specialised function such as Inspection or Plant Maintenance. It would be unusual to find Materials Handling as a separate account in the financial control figures of a manufacturing establishment and its importance as an expense item is therefore easily overlooked.

With regard to the second reason — that workers are reluctant to undertake unskilled work — there is perhaps little need to enlarge. It is in the sphere of materials handling that the heaviest and most unskilled tasks lie, tasks which involve little more than physical force and in which the performer can find

little satisfaction or pride of achievement. Small wonder that however well paid, such jobs are not popular and are, in fact, the centre of a large proportion of the country's industrial disputes. The human body is a feeble and expensive producer of mechanical power and apart from the implications of social duty, it is clearly in the interests of Management that available man hours should be devoted to work which demands a higher degree of skill and makes greater use of the potential abilities of the present day worker.

The slogan "Handling adds Cost but no Value to the Product" has been widely quoted but can be misleading. The problem of handling materials will always be with us in some form or other and, insofar as handling involves transportation, it could be said that materials have no value at all until they have been brought to the position at which they can be used, that is, until some handling or transportation cost has been expended upon them. It may, therefore, be more realistic to recognise that essential handling does increase value, that it is a necessary expense but one which, in common with all costs, we should strive to reduce to a minimum.

Scope for Improvement

The keynote of this Conference is "Investing in" and before one can persuade people to invest one must demonstrate the extent of the market and the possible return. It has been said above that materials handling costs are seldom isolated in company accounts, but data are available from which reasonable estimates of the extent of this field can be determined. This Paper deals primarily with materials handling in manufacturing industry and although many of the points made may be applicable elsewhere, the figures given do not cover activities such as mining and quarrying, stores and warehouses, or road, rail and water-borne transport.

Some 9,000,000 people are engaged in manufacturing industry in Great Britain. Practically every task involves some measure of material handling, but if we consider only such trades as transport drivers, stores staff, goods receiving and despatch men, shop labourers, factory internal transport men and crane drivers and slingers, a brief survey covering a number of manufacturing industries indicates that on average approximately 15% of the total number employed, after correction for such clerical duties as may be performed, are concerned solely with handling materials. The variation over individual industries is very wide, but it is reasonable to assume that over all manufacturing plants in Great Britain some 1,350,000 persons are engaged mainly on material handling. This represents a national wage bill of about £475m. per annum. In particular the average engineering shop on batch production employs between 10% and 15% of its total workers including staff on handling, and in a thousand employee plant of this type, the annual wage bill for handling will be about £50,000 per annum. Potential savings will, of course, depend on circumstances in each individual case and will come not only from a direct saving on handling labour. The possible advantages of sound handling methods and improved factory layout have been listed previously and the most important are probably the following :-

1. reduces handling labour costs ;
2. reduces direct labour costs ;
3. increases factory capacity and output ;
4. reduces volume of work in progress ;
5. reduces scrap ;
6. assists maintenance of quality standards ;
7. reduces accidents ;
8. improves morale of men by raising standard of skill and eliminating hard manual labour.

Savings will accrue under any or all of these headings although it may not be possible to express the advantage as an actual cash figure in every case.

It is very dangerous to generalise in these matters, but the writer feels that if the problem is to be properly appreciated, some figures, however approximate, must be quoted and it can be said from experience that in an average engineering shop of a thousand total staff, where materials handling has not previously been given special attention, one might well expect to realise a saving of the order of £10,000 to £50,000 per annum as a result of applying the best materials handling principles. It must be emphasised that these are purely general figures and are quoted only to give some idea of the dimensions of the problem. They do, however, indicate the extent of the return which may be expected and show clearly that it is at least worthwhile for one of the senior engineers on the staff to spend a few weeks on a survey of the possibilities.

For the purpose of obtaining another yardstick it is also useful to consider how much might be invested in capital plant and/or investigation time to save one man. It is fair to assume that the average man in the trades mentioned above earns at least £400 per annum and his employment will also involve some immediate oncosts in respect of insurance and pension contributions, holiday pay, canteen subsidies, etc. These additional expenses will, in the average case, make the total cost to the employer approximately £450 per annum.

If this amount is devoted to capital work it will be expended on interest on the capital invested, depreciation and cost of maintenance and running expenses of any plant installed. In these days of the credit squeeze 7% must be allowed for interest and, for electric powered equipment, it would be fair to allow 15% per annum on the capital cost for maintenance and running expenses. If the whole of the capital is depreciated or written off in one year, the following simple equation results :-

$$£450 = C + \frac{7}{100} C + \frac{15}{100} C$$

Where C = the capital cost to 'break even' in one year

From this it will be seen that $C = \frac{£450}{1.22} = £369$

In other words, and in a form commonly used, to save one man and for the equipment to 'pay for itself' in one year an investment of £369 in capital plant can be afforded. This is a very conservative calculation as it assumes that there are no other benefits beyond the saving of labour resulting from the installation and to allow only one year for recovery of the costs is asking for very favourable terms indeed. The breakeven or 'write off' period required will depend upon circumstances in each individual case and the above formula if modified to give the justifiable investment for longer periods gives the following results :-

'Write Off' Period in years	*'Breakeven' Capital Investment per Man Saved*
	£
1	369
2	625
3	814
4	957
5	1,070
6	1,165
7	1,240
8	1,303
9	1,360
10	1,405

It is emphasised again that these figures are quoted only to give an indication of the investment possibilities and any particular project must be the subject of a savings calculation which takes into account all local circumstances. The subject of savings calculations will be dealt with in greater detail in a following section.

Materials Handling and the Design of Factory Buildings

In the case of new factory projects, Management have the opportunity to make provision for ideal material handling conditions from the beginning. Minimum capital expense is often an important requirement at the start of a project, but it must be realised that whilst initial economy in the provision of plant and machinery can be relaxed later and improved equipment installed, changes to the building fabric are much more difficult to make at a later stage. Experience shows that even where building limitations are accepted at the inception and it is fully appreciated that changes will be necessary later, those changes are in fact seldom made and features adopted for the sake of a small economy in first cost, continue ever afterwards to be a source of loss and inefficiency. As a general principle, therefore, it is far wiser to budget for a building which will as far as possible be ideally suited to the manufacturing plan and its future development and if economies have to be made to make them in other directions. It should be remembered that the development of productive processes has resulted in a 40% increase in the national output in the last eight years. This development will continue and will inevitably increase the volume of materials which will pass to and from the production shops.

A whole book could be written on the principles of factory building design with reference to materials handling, but for the purpose of this Paper it will be more useful to list some of the features which experience has shown are often ignored. Apart from the first and obvious need to lay out buildings for the best material flow conditions, it has been found that it is important to give particular attention to the following points :-

1. Gangways and corridors along which material is to be carried must be of generous width and if flow takes place in both directions should be wide enough to allow two trucks to pass.
2. Permissible floor loadings, particularly on upper floors, should be adequate to support stores where materials may be stacked almost to roof level and to permit the operation of relatively heavy equipment such as fork trucks. Even on ground floors and particularly where the factory is built upon made-up ground, this is an important point and fatal accidents have occurred where a ground floor, usually a corner, has collapsed into the subsoil under the weight of a high stack of steel forgings or other heavy and dense materials.
3. Maximum use should be made of gravity for assisting material flow and corridors and even factory floors have been built with a slight grade in the material flow direction. Such grades can be imperceptible to a walker, but they assist hand trucking considerably.
4. Many process operations such as drying, ageing, stoving and even test running can be mechanised by conveyors and arranged to provide transport from one department to another during the process time. This is a particularly useful principle to adopt when for some other reason material has to flow against gravity from a lower to an upper floor.
5. Stanchions and steel work generally should be strong enough to carry lifting tackle wherever its use can be foreseen and roof trusses should be arranged at right angles to the material flow to allow runways or overhead conveyors to be conveniently mounted.
6. One loading bay serving goods received and despatched is often a false economy. Although total traffic may not be dense this arrangement increases the possibility of two or more lorries arriving together and if the finished goods are pilferable the opportunities for theft must also be considered.
7. Lifts and hoists are often placed against an outer wall when a little extra expense in steel work would allow them to be placed in positions giving much shorter average routes. The capacity of lifts and hoists should also be great enough to take power-operated trucks if there is any possibility that these will be used.
8. Floor ducts for main services should not be run along the main material flow lines or

corridors. If this must be done the ducts should be covered with a grill or cover of ample strength to support any vehicle which might pass over them.

9. The height of doors and openings should be such as to permit the safe passage of any material handling vehicle which is to be used. In this connection it should be noted that the lowered mast height of a 4,000 lb. fork truck may be not less than 10 ft. Rubber crash doors have proved to be very effective where draught exclusion and heating considerations demand that exits and entrances should normally be closed.
10. Access for lorries, particularly with reference to vehicles carrying bulk materials, should be of ample size and sufficient to take big road vehicles. The cost *per ton mile* for operating a 15-tonner is only 60% of that of a 5-tonner and clearly the tendency of road transport will be to use larger vehicles as time goes on.
11. Service departments, particularly stores,, which need to be partitioned off from other parts of the factory are commonly placed against an outside wall as this reduces the cost of partitioning. At present wage rates, it costs almost a penny in wages alone for a man to walk 100 yards and if a small tool store, for example, is placed in the centre of the machine shop the extra cost of partitioning may easily be regained in the first year of operation.

Survey of Materials Handling in an Existing Plant

The first step in undertaking a programme of improvement to handling methods in an existing plant is to make a general survey of the problem and it is essential to recognise this as an important and formal stage. The objects of the survey will be :-

1. to examine existing methods and difficulties ;
2. to determine present handling costs ;
3. to estimate the scope and nature of possible improvements ;
4. to estimate possible savings.

In other words the survey is a preliminary examination which will give an overall view of the problem from which plans for further detailed action can be drawn up. It should be the subject of a written report and must not be hurried ; it will involve a great deal of investigation and collection of data and above all it must aim at presenting facts as distinct from opinions and quantitative rather than qualitative estimates. In a 1,000 employee establishment, for example, the survey stage may take several weeks.

Whilst many worthwhile improvements can result from the examination of particular processes which may be causing immediate difficulty, it is usually far better to make the survey comprehensive, extending from the supplier of materials, through the factory, to the delivery of the finished product. The question of unit loads, standardisation of pallets and containers and the optimum utilisation of equipment, particularly mobile equipment, are only some of the factors in the problem which demand the widest possible view. This principle quite clearly applies to any examination of factory layout. Isolated improvements may be difficult to justify economically, but when all the possibilities, some of which may be mutually dependent, are known, previously unexpected savings quite often emerge. It is a matter of fact that consideration of individual processes will often show that no improvement is feasible and it is not until the whole material cycle is examined overall that the extent of potential savings can be appreciated.

It has already been said that materials handling should be regarded as a specialised function and if this is accepted, it should be organised as such. Someone should be appointed to deal with it and this might best be a member of the Process Planning Department staff. A great deal of technical literature on handling has been published, equipment manufacturers are very willing to demonstrate and give information about their products and there is no reason why an intelligent engineer should not quite quickly acquire a sound knowledge of the latest materials handling methods. The services of consultants are also available and many of the larger firms in this country have appointed a materials handling engineer as a separate specialist post. In the small firm it may have to be a part-time job for some individual, but the important thing is that whoever is appointed must be in a position to view the problem overall. All staff concerned in handling should, of course, be encouraged to take an interest and to make suggestions, but the best results will not be obtained if the problem is dealt with piecemeal.

The importance of getting factual evidence of existing conditions has been mentioned and may not be too strongly emphasised. In these days of scientific management it is staggering to note how frequently major changes in organisation, equipment and methods, often involving considerable expense are put in hand solely as the result of expressions of opinion. Particularly is this so when indirect or service operations such as materials handling are concerned. These are usually not cyclic, they often involve periods of idle time or stand-by time and are, therefore, not so easy to measure as direct operations. The techniques of work study and operations research are now highly developed and are readily available to provide actual measurement of existing conditions and to give close estimates of performance under any proposed improvement plan and should be used as far as possible.

At risk of labouring this point it must also be realised that human judgment is often hopelessly inaccurate when estimating physical quantities. Manufacturers of equipment report that they are frequently asked to quote for trucks or lifting devices capable of lifting or carrying loads of a weight far in excess of any that actually exist in the prospective customer's premises. Quite recently an enquirer who insisted on ordering a one-ton fork truck only desisted on being shown by actual weighing figures that he had no load greater than six cwt.! Another example of false impression was clearly shown following the study of the utilisation of an overhead travelling

crane in a heavy machine shop. As one would expect the crane was subject to random demand and in such circumstances it can be shown that if idle time of machine operators in waiting for the crane is to be reduced to reasonable proportions, the crane itself must have a high percentage of idle time. In this particular case, the results of the study showed clearly that additional lifting facilities were required, but it was extremely difficult to convince the shop supervision of this when, as they pointed out, their present crane was not 100% utilised.

Study and measurement of the actual operations will involve close observation and possibly timing and before this is done it is essential that the workers involved are fully informed as to the objects of the investigation. This should be dealt with through the usual negotiating channels, and experience shows that workers engaged on handling jobs seldom object to observation or timing when they realise that the outcome is likely to be a reduction in physical effort and possibly up-grading to a job in charge of some mechanical device.

The survey then will have as a first objective the collecting of factual data on the handling of materials from supplier to customer and to establish the overall dimensions of the problem it will be necessary to determine the present expenditure involved. It has already been stated that materials handling costs are seldom shown as a separate account in the normal financial control statements and it will, therefore, be necessary to enlist the aid of the Accounts Department to extract the figures required from the present records. It will, in any case, be necessary to prepare such a statement as a matter of routine in order to watch the progress of any improvements which are subsequently installed, and the opportunity should, therefore, be taken at this point to lay the basis of a procedure which can thereafter be readily applied.

It is not possible to lay down any fixed procedure for the conduct of the survey which must be programmed to the individual case, but as a general principle factory layout, that is, the relative positions of the various departments, is first to be considered. Attention should then be given to the various departments and this should preferably be done in the sequence of material flow. It is not the intention that improvement plans should be formulated in detail at the survey stage, but rather that the points where improvement should be possible should be identified for further examination. Some specific ideas will undoubtedly emerge but the main object should be to obtain an overall assessment of the possibilities and to obtain a rough estimate of the savings on present cost, and capital expenditure required. A draft programme to a time scale for implementing the recommendations should also be prepared.

Materials Handling in an Engineering Factory

The important points to watch in improving handling methods will, of course, depend to some extent on the industry in question, and a separate Paper could be written on each department. For the purposes of this Paper, therefore, it is proposed to consider a typical engineering factory on batch production and to limit comment to those weaknesses which are frequently evident.

Factory Layout

A large scale plan of the plant should be drawn with adequate space for notes to be entered. The main flow lines should then be marked on the plan and the rates of material flow, frequency, manpower, equipment and other relevant data should be noted at the appropriate points. This plan will not show movement within departments but points of exit and entry to the various shops will be shown. It will cover all materials whether direct or indirect and the data given must be supported by factual evidence. Traffic to and from the factory, for example, should be determined from inspection of the gate book, if one is kept, and goods received and despatch notes should be examined over the reference period. Numbers of staff employed should be checked by observation and examination of the wage book.

When complete the plan will then be examined and many alternatives will need to be worked out before the best solution is obtained. In principle, however, savings on re-layout will in general result from :-

1. reduction in distances moved ;
2. reduction in number of loadings and unloadings;
3. elimination of crossing routes ;
4. carrying as big a load as possible at one time ;
5. adoption of unit loads ;
6. mechanisation of transport and handling gear at transfer points ;
7. improvement of surfaces in the traffic lanes ;
8. improvements made under the points previously noted in connection with the layout of new buildings.

The resulting plan will inevitably be a compromise and may not necessarily involve any new building or movement of whole departments from one building to another. Much can be done by provision of exits and entrances at new points. Reference to suppliers and customers may show that alteration to loading or unloading facilities would permit cheaper packing or delivery methods to be employed.

Having arrived at the optimum layout and the best methods for inter-departmental handling, attention should then be given to the separate departments, although it is not advisable to finalise plans until all departments have been examined as changes in one may often be dependent upon changes in another.

Goods Receiving Department

Methods of packing by suppliers for ease of handling and checking in the Goods Receiving Department can often be improved. Goods may often be left in the original packing for ease of handling in the stores and shops, but returnable cases and packing materials are sometimes charged by suppliers at a very high rate to ensure their prompt return. Negotiations with suppliers may resolve this difficulty. The amount of inspection carried out on goods received will, of course, depend upon the risk of deterioration or damage in transit and the dependability of the supplier, but it should be remembered that quite often it will simply repeat the final inspec-

tion which the supplier himself has carried out. If the supplier's final inspection methods are acceptable they may be specified in the purchasing contract and goods received inspection considerably reduced. An adequate supply of packing blocks should be available so that goods and cases need not be placed directly on the floor. Subsequent lifting by fork trucks or the attachment of crane slings will then be simplified.

Stores

Maximum utilisation of floor area in stores is often the most pressing problem, but care should be taken in specifying high storage racks as the labour and risk of injury involved in getting up to the top row of bins may more than out-weigh the space advantage. As a result of experience, stores staff will often have arranged that the articles in most frequent demand are close to the serving hatch, but this is not always the case and an analysis of requisitions over a period will permit the best arrangement to be devised. With reference to space utilisation and location of items a well-known manufacturer of stores equipment has recently shown that where items can be stored in unit loads for handling by fork trucks, block storage, that is to say storage of the units or containers in a block seven or eight deep and say, five high by twenty in length, can be more economical overall than storing in rows only two deep, although the latter arrangement gives much simpler access to any one unit. The optimum dimensions of the block depend upon the frequency of movement of the units, but it is clear that the rapid and easy handling afforded by fork truck operation so reduces handling costs that accessibility becomes a minor factor compared with the saving in floor space by reduction of gangways. With this system it is necessary to maintain an accurate record of the location of any one unit and the general method of operation is explained in greater detail in Fig. 1 (page 555).

Under effective production control conditions production material stores should be regarded as a marshalling or re-grouping point, rather than a stocking area in which relatively large quantities are held and issued in small amounts. This particularly applies to Finished Part stores and where components are in continuous production they may often be delivered direct to racks on the assembly bay or line with considerable economy in handling. The greater part of the labour cost in stores departments is expended upon putting materials into bins and racks and extracting those materials at a later stage for issue. Whatever physical storage arrangements are made, therefore, should be designed with the object of facilitating these operations. Neat regular rows of bins extending almost to ceiling height may look impressive and give high utilisation of floor area, but adequate arrangements must be made for the stores staff to place and withdraw items from the highest compartments without difficulty. A small stores issuing truck in which items to be issued can be collected and which carries a short ladder permanently fixed at one end is on the market and is obviously a good method of improving bin access.

Machine Shops

The compilation of flow process charts to analyse either general material movement or the flow of individual components is a most useful way of approaching the problem of machine shop handling. Flow process charts have been very adequately described in the productivity report and in many Papers and books on materials handling which have since been published, and it is not proposed to describe them in any detail again in this Paper.

The main principles of improvement are :—

1. to reduce distances moved;
2. to reduce the number of loadings and unloadings.

Reduction of distances moved will automatically involve study of the general shop layout and may finally result in a plan for revision. Distances are again a feature upon which mental impressions are liable to be misleading and in considering the movement of a component it may be felt that the time saved in moving a batch 10 yards instead of 100 yards after an operation which has taken two or three hours to perform is negligible and not worth worrying about, but the point to be borne in mind is that such movements are usually carried out by shop labourers who are entirely occupied throughout the day on similar work. If their journeys can be reduced by half, obvious economies will result.

It is not proposed to extend this Paper to any detailed discussion of the automation of actual processes, excepting to note that with direct operators the question of distances moved is also of great importance. The work which has been done on predetermined motion times over the past 20 years shows very strikingly the benefits to be obtained from a study of the work place with the object of reducing the distances of the motions made, the amount of precision involved and the possibilities of simultaneous motions of both hands. A graph of the basic motion time study values for a simple reach is shown in Fig. 2, and it will be seen that if a reach of 20″, for example, is reduced to 10″, the motion time drops from 102 to 81 ten thousandths of minute. This is a 21% reduction and although the time saved over one motion may appear microscopically small, it will be realised that where an operation consists almost entirely of handling and transportation motions of this kind, substantial economies can be obtained if the distances moved can be reduced. Again with regard to precision the value of 102 for a 20″ motion has to be increased by 48/10,000ths of a minute if the accuracy at the end of the movement has to be within a tolerance of ¼″. This represents a 47% addition to the motion time and illustrates the importance of reducing precision by providing generous leads about location points in jigs or fixtures (see Fig. 2 page 555).

Reduction of the number of loadings and unloadings will usually involve some revision of shop procedure. In order to keep the shop floor clear, for example, many firms provide work-in-progress stores where batches of components are held between operations. In the writer's experience, work-in-progress stores are always full no matter how big you like to make them and although the complications of

machine loading may make their use inevitable, they are to be regarded, to some extent, as an admission of defeat on the part of the production controller. Many modern machine tools of the smaller type need not be grouted to the floor and it often pays to move such machines about to form lines for a line production system even when runs are comparatively short. Previous writers have also indicated how inter-operation and counting operations may often be reduced in number and it is noteworthy that counting operations in particular are often carried out for no other purpose than to ensure prompt payment of piecework bonus under a system of payment by results. A detailed progress record showing quantity finished, rejected, held for rectification, etc., at each operation is usually maintained by the Progress Department and if job cards are checked against this before payment, the possibilities of error can frequently be eliminated without the need to make an actual physical check at every stage.

Process Shops

With processes such as plating, heat treatment, painting, drying, etc., the labour employed is almost solely devoted to handling. The processes are often of a fixed nature and conveyors can often be installed to carry the various components through the process. Apart from the obvious labour saving, mechanisation in this way will ensure regularity in the process cycle and improve the quality of the work. Quite frequently it is also possible to arrange that the operators at the stations immediately before and after the process can load the articles on to the conveyor and take them off as a part of their own work cycle.

Assembly Shops

In assembly shops again, the various operations are almost entirely handling, but unfortunately these jobs frequently receive insufficient attention from the Planning Department. One often finds very detailed and complete operation layouts drawn up for machining and process operations, but if a layout for assembly is issued at all, it carries only the bald instruction 'assemble complete' and in the column headed 'Tools' the ubiquitous word 'Miscellaneous'.

The assembly shop is therefore often a very fertile field for the materials handling engineer and marked improvements can usually be made. Apart from study of the procedure adopted in laying out the components and the sequence of assembly, the provision of benches of the right height and fixtures which, although not necessary for purposes of accuracy, allow the main components to be held in the most convenient position are worthwhile investments. In the design of turnover fixtures for heavy components, care should be taken to position the pivots so that the axis of rotation passes through the centre of gravity of the fixture and component combined. Quite heavy articles can be turned over easily by hand if this principle is observed.

No note on the improvement of assembly operations should fail to mention the importance of providing proper small tools for the job. Too frequently the operator has only a collection of standard tools, often his own property, which are in poor condition. Gaping, open-ended spanners and worn and distorted screwdriver bits play havoc with knuckles and tempers, not to mention their effect on the finish of the completed job. The provision of special spanners of the right length and to give the right leverage, extractor tools, drifts and punches and small tools generally, does not normally involve great expense and reduces assembly costs and the possibilities of scrap.

As in other process shops, reduction of handling and fetching and carrying may also involve improvements in procedure. An appropriate marshalling area should be provided either in or adjacent to the finished part stores, so that complete sets of components can be grouped together before issue for assembly. Apart from ensuring that no shortages are present when the job is issued to the shop, this procedure enables an actual physical check to be made and any errors in progress or stock records corrected.

In quantity production the application of conveyors to carry the product from one assembly station to the next and to feed the main assembly line with components is well-known. Such set-ups are very efficient, but involve very careful planning and work study of the operations to ensure balance. It must be remembered also that on an assembly conveyor line, delays due, for example, to operator error or failure of parts to assemble, are cumulative in their effect and this point must be clearly recognised before the conveyor set-up is installed.

Test and Inspection

The remarks made on possible improvements in other shops may apply also to test and inspection operations. These again are largely handling operations although a certain amount of expert knowledge may be involved. Although gauges and equipment which are an absolute technical necessity are specified and provided, handling fixtures and matters of departmental layout to facilitate the work are often just not thought about. The possibilities of conducting running tests whilst the products are in transit on a conveyor from one department to another have already been pointed out in connection with factory layout features.

Packing and Despatch

Packing and despatch operations are very similar to the work carried out on the goods receiving bay, but in reverse. The same points need watching and goods should not be placed on the floor, but an adequate supply of packing blocks should be available so that the goods can be placed on them and lifting by fork trucks or slinging for cranes simplified. It should also be noted that much of the work lies in handling packing materials as well as handling the goods themselves. Close control of the arrival time of transport for loading will also eliminate handling involved in stacking packed goods to await loading on to the vehicle. In this connection the merits of the detachable trailer-type vehicle should not be overlooked. Extra trailers can be held in the loading

bay and loaded as the packed goods become available, whilst the towing unit and driver are out on the road making other deliveries.

Mechanical Handling Devices

No Paper on materials handling would be complete without mention of mechanical handling devices, but it is proposed here to treat the subject in a purely general manner and not to attempt to describe the technical features of fork trucks, conveyors or other handling plant. Available equipment has been very fully described elsewhere and the recent Mechanical Handling Exhibition at Earls Court gave a very complete and comprehensive display of the latest machinery. It has already been said, however, that the human body is a puny and expensive producer of mechanical power and the advantages of employing mechanical equipment wherever possible are perhaps best illustrated by considering a few comparative figures.

The power that the human body is capable of developing varies widely not only with the individual, but also with the conditions of working, the muscles used and the duration of the exercise. Under ideal conditions for power development such as bicycle riding, a trained man can maintain an output of about $\frac{1}{8}$ horse power for several hours and for a short period of two or three minutes, can achieve as much as $\frac{1}{2}$ horse power. Under normal factory labouring conditions, however, such as lifting and carrying materials, it is only on what would be considered to be the hardest tasks than an average of more than 1/25 horse power is developed and over a working day this would result in an energy production of some 630,000 ft. lb. If the cost of this energy is eight hours wages at, say, 3/9d. per hour it can be shown that it is over 600 times more expensive than if we buy it from the electricity company at the current average industrial price of 1.8d. per KWH and convert it at 75% efficiency. In making this comparison it must, however, be borne in mind that for 3/9d. per hour we are also hiring the equipment itself! And what a complex and elaborate equipment it is — needing only a few words of instruction to set it up, complete with built in memory unit, capable of judgment, selection, and a very wide range of activities. Surely it is a shocking waste to use it simply as a lifting or transporting device. It may also be said that this complex mechanism has a will of its own and can even get out of control — but that is another subject!

The reluctance of labour to undertake heavy and monotonous manual tasks was put forward as the second main reason for the increased attention which is now being given to the subject of materials handling, and experience has shown that in no other activity do men more welcome the introduction of mechanical aids. Operators in charge of power-operated plant acquire a much greater pride in their job and very quickly achieve a very high degree of skill in operating the equipment.

In installing mechanical handling plant it should be noted that handling services are usually in random demand and it is, therefore, impossible to expect 100% utilisation. This fact must be recognised, but is no argument against installation of the machinery if its provision even at low utilisation can be economically justified. In big establishments covering a large area substantial economies and improved service have resulted from the installation of a central control office for internal transport. Drivers report to the control office by telephone and are directed to the next pick-up point without delay.

Another argument frequently advanced against mechanisation generally dwells upon the awful possibilities which would arise if the plant broke down. This is an argument which can be made much of in the absence of actual experience, but the facts are that mechanical plant purchased from reputable firms and properly maintained is extremely reliable and the risks of breakdown are certainly no greater than those of the incidence of sickness or absenteeism. In any event mechanisation is a continuous development and in any industry where mechanical equipment is now in use, to consider the possibility of going back to hand working would be ridiculous. Yet when that degree of mechanisation was first introduced, there were undoubtedly people who were reluctant to change over from hand methods for the very same reasons which are quite fallaciously advanced against further mechanisation today.

Calculation of Savings

The need for actual measurement and determination of facts in comparing present and proposed plans has already been emphasised and this principle must be continued to the calculation of expected economies. In any given scheme there may be advantages or disadvantages to which a cash value cannot easily be put or which are of a very long-term effect and unlikely to make any immediate change in expenditure or income. Nevertheless, some estimate or calculation of cash must be made, or at least a positive or negative value given to each factor, if we are to distinguish the things which are worth doing from those which would only be nice to do. This may entail taking some trouble and making tedious analyses, but it should be remembered that the savings will accrue indefinitely, whereas time on investigation is expended once only.

The actual formulae used in computing savings are relatively simple and need not be dealt with in detail, but there are certain points of principle on which some confusion often exists. These are discussed in the following paragraphs.

The depreciation rate of the capital expense involved is usually expressed in terms of the 'breakeven' period for the project and in many organisations it is surprising to find arbitrary rules in force to the effect that for adoption the improvement must 'pay for itself' in two years or some similar, but usually short, period. No doubt such rules include a hidden contingency factor to cover for the possible failure of the scheme or a reduction in the market for the product. If this is so then the possibilities of failure should be minimised by more detailed investigation and it should be remembered that any improvement which will reduce product cost and hence permit a lower

selling price, is simply a guarantee of a continued market. Where it can clearly be seen that the scheme will only be applicable for a limited period, that period should certainly be adopted as a basis for savings calculations, but where a capital improvement will be in use indefinitely, then the first cost should be written off over the expected life of the equipment. In general it is felt that in this country we are much too conservative in making savings calculations on method improvements and the adoption of arbitrary rules, such as those quoted above, only result in many worthwhile plans being rejected. In starting a new venture, no one would think of writing off plant and equipment in two or three years — why then apply such a rule to additions ?

Overhead charges are another element in savings calculations on which theory and convention are often permitted to distort results. It is not unusual to find that overheads at current costing rate are taken into account in computing the savings on direct operations, but are omitted when dealing with an indirect activity such as materials handling. There is no mystery about the inclusion or exclusion of overhead charges in a savings statement and it is far better to be quite factual than to adopt a general rule. The various overhead accounts should be examined and the expected increase or decrease in expense under each heading which will arise from adoption of the proposed improvement should be assessed or if possible calculated. In this connection another factor in support of making a comprehensive survey of handling problems becomes evident. If one particular improvement is considered alone it is often impracticable to gain any economy in overheads because the change is too small to make any difference, whereas the effects of a number of proposals taken together may be substantial and real.

If the expected result of making the change or changes will be an increase in production capacity savings will be very much increased if calculated on the basis of increased output. This is because many of the overhead charges will remain fixed and will not be affected by a greater output and a slightly increased total overhead charge will then be spread over a greater increment in production. In such a case total savings should be calculated in the following manner :-

$$\text{Total Saving} = \left[\left(\begin{array}{c}\text{Present production}\\ \text{cost per unit of}\\ \text{output}\end{array}\right) - \left(\begin{array}{c}\text{Expected production}\\ \text{cost per unit of}\\ \text{output}\end{array}\right)\right] \times \left(\begin{array}{c}\text{Expected}\\ \text{production}\\ \text{units}\end{array}\right)$$

Care should be taken in calculating savings on an increased output basis unless it is perfectly clear that market conditions will allow the extra production to be sold.

Attention should also be drawn to the computation of capital expense required. This is sometimes confused by taking 'book values', that is, the values shown in the company's capital accounts, for redundant plant and equipment. Such values may not always be true and whatever errors in rates of writing off may have been made in the past, they should not be allowed to influence consideration of the worth of a proposed change. In purchasing new plant to replace old equipment the cash required will be simply :-

Cost of new plant
Plus installation charges of new plant and dismantling charges in old plant
Less market value of old plant.

As a final point on savings calculations it is a matter of opinion whether the incidence of inflation should be taken into account, but it is at least a factor on the positive side. Wage rates have increased by 54% over the last eight years and it is undeniable that capital expenditure on an improvement introduced in 1947 will now be yielding savings on labour charges considerably greater than those calculated at the time. Inflation does appear to be a continuous process and although the present rate may be reduced over the next few years, there is little doubt that it will go on to some extent and it is clear that capital invested in plant now will pay increasing dividends as time goes on.

Implementation

The implementation of any improvement plan, unless it is a very small one, needs careful planning. If this is not done there is a great risk that mistakes will occur and the whole scheme may be discredited. At best there is a risk that the expected savings may not be realised. A programme against a time scale should be drawn up to show all significant dates and it this is prepared in chart form the chart can be used for progress purposes. A proper plan will ensure that the various changes are made in the right sequence and will enable cash requirements to be anticipated. If there is any question of labour redeployment or redundancy the total effects can be seen and the whole problem discussed and plans agreed with the workers' representatives in good time.

For control purposes arrangements should be made with the Accounts Department for the regular preparation of a materials handling account which, if it is not convenient to incorporate it in the standard accounts, can be in memorandum form. The account should be produced regularly and preferably monthly and its primary purpose would be to show the progress of the application and to ensure that the expected savings were being achieved. As in the normal course of business production volume may vary from one period to another, it is desirable that an index of materials handling efficiency should also be calculated for each period. This might be expressed as the materials handling cost per unit of direct output, per direct standard hour, per pound of sales, or whatever variable is convenient and is a reasonable measure of materials handling activity.

Conclusion

In preparing this Paper the writer has endeavoured to illustrate in cash terms the extent of the materials handling problem in manufacturing industry and the scope for improvement. Particular emphasis has been

laid upon the desirability of making a complete review of handling methods in an organisation rather than to deal only with immediate but isolated problems. Except to quote various features which the writer has found to be of general importance in considering handling methods, it has not been possible to devote space to purely technical information, but the vital importance of basing plans for improvement upon actual measurement and calculations using all the available techniques of work study and operations research has been pointed out.

In general capital investment in improvements to handling methods pays handsome dividends and where heavy manual tasks are concerned is clearly essential, as the labour force available for such work is shrinking rapidly. In manufacturing industry the scope for improvement is often hidden, but spectacular results can be achieved if the subject is tackled in a wholehearted manner.

Finally, the writer wishes to record his appreciation of the advice and assistance given by his colleagues in Production-Engineering Ltd. and Combined Technical Services Ltd. in the preparation of this Paper.

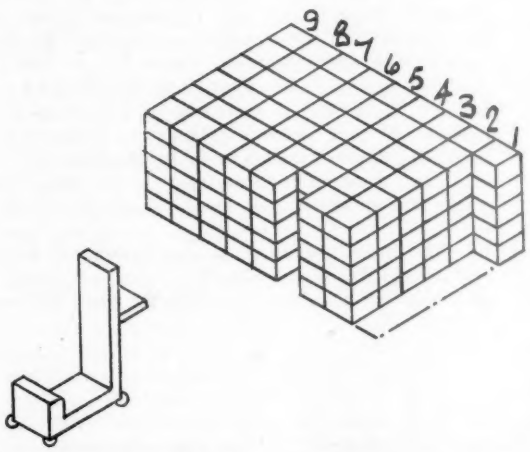


Fig. 1. Block Storage of Pallets or Containers. The diagram shows a block of pallets tiered 5 high and stacked 6 deep. When first arranged Row 1 is left empty. If it is then desired to remove a pallet from the third stack in Row 4 the first stack in Row 4 is moved to become the sixth stack in Row 1. The second stack in Row 4 becomes the fifth stack in Row 1 and so on until access is gained to the desired pallet. The pallets moved to Row 1 are not then moved back but their new location is recorded by moving numbered tallies on a control board. The board is, in effect, a model of the block.

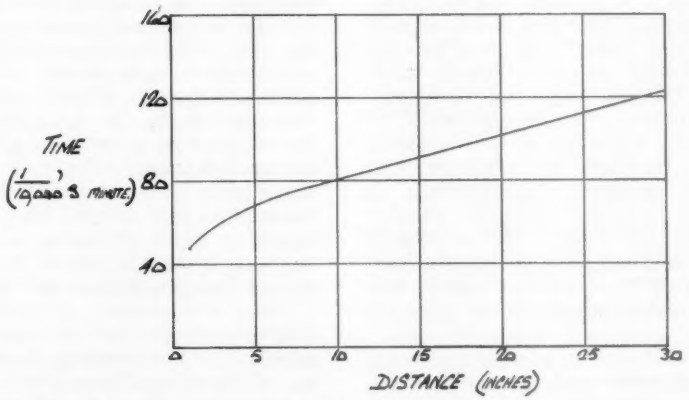
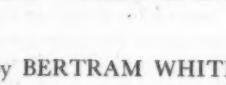


Fig. 2. Basic Motion Time Study Values for Class 'C' Reach.

SESSION XIV

INVESTING IN BETTER UTILISATION OF RESOURCES

by BERTRAM WHITE, B.Sc. (London) in Chemistry.
Fellow of Royal Institute of Chemistry.



Mr. White

Mr. White before the war was at Cadbury, Bournville; first in the Chemists' Department, then Production Department. During the war he was first Assistant Superintendent in charge of production at a large Government ammunition filling factory. Later he was Chief Capacity Officer organising planning of industrial capacity at the Ministry of Production. From 1944-46 he was Consultant with Associated Industrial Consultants Limited, and from 1946-53 he was Technical Director, Federation of British Industries. The main employers' national body dealing with commercial, economic and technical problems in industry. During this period he was a member of two teams sent to the U.S.A. by the Anglo-American Council on Productivity.

Mr. White joined A. Boake, Roberts & Company Limited in April 1953 and is now Managing Director. The Company manufacturers a wide range of chemicals, plasticisers, perfumery bases, flavours and essences.

IN a sense this subject spans the whole range of the Papers presented at the Production Conference, for the core of the problem posed by the titles "Production for Plenty" and "Investing in Success" is how to utilise better our total resources—of materials, machines, money and men. Some reference is therefore necessary to subjects already considered, or still to be considered, since most of the other Papers deal in greater detail with methods of improving utilisation of resources in selected fields of endeavour or through the employment of particular methods or techniques.

Better utilisation of resources is at once the main problem for management in industry and for Great Britain in the world today. The chief way to expand industrial production is to make better use of existing resources, and the prospect of making Britain stable and safe in a world growing more and more competitive is largely dependent on improving the utilisation of British resources, These two things are linked, for Britain depends increasingly on an efficient and expanding industrial economy. Improvement is necessary merely to maintain Britain's existing position in the world. To achieve the politician's dream of doubling living standards in twenty-five years demands intensive efforts from industry which must be based mainly on existing resources.

The Problem

Over and over statesmen and economists have emphasised the perilous dependence of Britain on the rest of the world. Repeated stress has been laid on our country's inadequacies of natural resources and on our limitations of geography and population. Familiar as the statements are, they must be uttered again and again in stark and simple terms until the dangers of our situation are realised by everyone and the right remedies applied. In particular, management in industry should appreciate the problem and strive to contribute to its solution.

Britain has few resources of native materials for industry and all are wasting assets. Moreover, the cost of winning these raw materials rises steadily and will probably continue to rise for decades to come. Thus more and more capital is consumed to maintain coal output at a roughly static level and it is hard to visualise any radical improvement in supplies of this, our main indigenous raw material. There are, moreover, indirect repercussions. For example, the high price and shortage of coal have diverted many fuel consumers to the use of oil, thus compelling the outlay of hard-won foreign exchange and increasing strategic dangers. The same shortcoming has no doubt given impetus to the development of atomic energy as a fuel source. Had coal been in plentiful supply at lower prices, it is conceivable that the emphasis of atomic energy development might have been different and more rewarding.

Some raw materials at present plentiful and inexpensive are likely to be scarce and costly within a generation. For example, there are signs that shortage of water may limit the development of some of the process industries such as food and chemical manufacture unless stern conservation measures are

observed. Water supply already determines largely the location of new factories in some industries.

During post-war years there was, for a time, great difficulty in obtaining new plant and machinery to re-equip British industry, partly due to shortage of machine-building capacity, partly due to the necessity of exporting British machinery. The pattern of demand in exports has been changing over a long period of time and capital goods are now being demanded where consumer goods were previously sold abroad by Britain. The capacity of the machine-producing industries has been greatly expanded, but British industry still needs, and for years to come will need, to obtain maximum performance from existing plant and machinery. The same comment applies to industrial buildings where the desire to improve or reconstruct is limited by resources of one kind or another.

As to money, recent events have made painfully clear to the industrialist, if not to the man in the street, that the financial resources of the country are already over-strained and that adjustments must be made. In this process there is bound to be, indeed there is already, some restriction of industrial expansion and change which demands additional finance. There is an evident intention on the part of government to make money scarcer and more costly and to use this weapon to relieve the over-strain on our resources. The effect will not be selective except in the broad sense that marginal projects of doubtful profitability will be discarded and there may be increased concentration on the soundest schemes. Whatever the merits of such monetary policy it is evident that there will be, for some time to come, a restriction on the flow of money for industrial expansion. Moreover, the high level of taxation on industrial profits puts a severe limit on the ability of a company to finance expansion from its own earnings. With money, as with materials and machines, the industrialist must concentrate on better utilisation as a means of future improvement.

So much for materials, machines and money. And what of the men (not forgetting the women)? Of a population of fifty millions some twenty-five million are in "gainful employment"; unemployment stands at less than 300,000 and this figure includes those not fit for employment and those merely in transition from one job to another. In some specialist categories the manpower problem is acute and emergency measures are being taken. Employment is at the highest level in the history of the country and unemployment is at the lowest. In general terms, it is abundantly clear that there is no large unused surplus of manpower and that further expansion of industry must rely on better utilisation of existing manpower.

In all the main categories into which for convenience resources have been analysed (materials, machines, money, men) there is shortage of supply real or apparent. If, therefore, the present urge for expansion, for improvement in living standards is to be gratified it must be, it can only be, through better utilisation of existing resources. This argument has been developed at some length in order to establish clearly that this is the overriding task for managements who wish to promote the well-being of their companies and of the nation.

Facing the Task

What has gone before is no more than a statement and a rough dissection of the problem. There are two ways in which action can be taken, firstly, by the Government and secondly, by industry.

It is for the Government to create the right economic conditions, the right "climate", and the right inducements so that industry can make its most effective contribution. To the extent that Government policies and actions limit and hamper the more efficient development of industry, then to that extent the development of greater prosperity for the country as a whole is hampered and limited. Above all, it is for Government to create a national awareness of our present limitations and dangers and of our dependence on a highly efficient manufacturing industry to provide the main remedy for present troubles. Government alone can create the needed urge to greater prosperity through better use of all our resources. Government can and should help to engender a sense of common purpose from board-room to shop-floor. But managements in industry cannot leave this task to Government.

There is another sphere in which Government can act, though there are arguments for and against such action. Some insist that a comprehensive survey of all resources should be carried out under Government auspices, perhaps by a Royal Commision. In the United States the "President's Materials Policy Commission" has been for some years conducting such a survey of resources within the U.S.A. and outside it. This Commision under the able chairmanship of Mr. William S. Paley has examined in considerable detail a vast field of resources, actual and potential, with a view to establishing wise long-term policies for production and consumption. In Britain the approach is more piecemeal and surveys have been made on particular fields, e.g., coal and other minerals, water supply, without cross-reference or correlation. Some consideration might be given by the Conference to a more comprehensive attack on this problem by Government.

While a sketch of the problem on these broad lines may be useful as a background, the important question to managements in industry is how they can make their contribution. What are the practical steps that can be taken to improve utilisation of resources in manufacturing industry? The remainder of this Paper is therefore concerned with this aspect and the suggestions made are based on practical experience. They are not new, neither are they comprehensive—but they will perhaps serve to initiate discussion and stimulate further proposals; once more, for convenience, the four divisions, MATERIALS, MACHINES, MONEY and MEN, are employed.

Deciding the Priorities

There is a wide divergence in the importance to different industries of effective utilisation of the various types of resources. For example, in work involving high manipulative skill such as instrument manufacture the material cost is insignificant, while

the labour cost is of great consequence. In a steel mill the equipment is very expensive and high utilisation of plant is a dominant consideration. In large-scale chemical manufacture labour cost may be low, but material cost and plant cost may be very high. Here it will be important to raise the efficiency of the process and to obtain maximum utilisation of the plant. The remarks made about materials, machines and men will therefore apply in widely differing degree to different industries. But efficient utilisation of money is a problem common to all types of industry.

Generally speaking, therefore, an analysis of costs and sometimes of turnover or profits will aid in selecting the point of attack. There are several methods which can be employed and to which further reference is made below. A good starting point is an analysis of the make-up of the value of the products of the company as a whole, or of selected groups of products, or even of certain individual products. This analysis should show such factors as :-

Labour.
Supervision.
Maintenance.
Services (gas, water, electricity, fuel, etc.).
Depreciation of plant.
Raw materials.

An amount must be shown for general expenses or overheads, often calculated as a proportion of other charges. It is often useful to consider also the land, buildings and plant involved, though this may to some extent be indicated by the depreciation charge. To round off consideration of the "Money" factor, figures will be needed for the value of raw material stocks, work in progress and finished stock, debtors and cash, with an adjustment for creditors.

Consideration of this information will enable management to select the sectors of resources which demand the initial attack.

MATERIALS

The first step is to obtain information about the amount of material consumed per ton, pound or other unit of product manufactured in *saleable condition*. Existing recording systems may not be adequate in quantity or quality to provide the necessary information. Where material costs are important the expenses of an accurate stock recording system is usually recovered many times over by improved material utilisation which springs from better measurement. The disclosure of poor utilisation of materials is the first essential step in planning improvements.

There are many ways of attacking poor utilisation of materials. Sometimes the fault may be traced back to poor product design resulting in waste of material or a high proportion of defective products. Here the remedy must lie with the designer and fundamental changes may be needed. Or the raw material may be unsuitable for the product or the process, in which case better materials must be sought. Here the help of the supplier may be valuable and that help can often be most useful if the supplier is given access to the faulty process and allowed to suggest remedies. The supplier may well have experienced similar problems with other customers. There is the danger that so-called secret processes may thus be disclosed, but this risk can be exaggerated.

Poor control of process or production methods is a frequent source of low material utilisation. The techniques of inspection and quality control can be employed to analyse the causes and point the way to remedies. Thus, in repetition operations in an engineering shop, quality control techniques can lead to better adjustment or tooling of machines. Sometimes inspection limits are set too tightly and the customer might be prepared to consider wider tolerances permitting less scrap and lowering costs and prices. On the whole, British practice tends to be based on the maxim : "Only the best is good enough" while in the United States the outlook is more nearly : "Good enough is best".

In process industries such as chemical manufacture, the remedy may lie in research on the process and months of laboratory work may be needed to establish a more efficient method and process. The design of plant may be imperfect, and reaction vessels, distillation columns, heat exchangers or other equipment may not be capable of the duty expected. Here chemical engineering investigation may be called for, leading to plant alterations.

Again, ignorance of what is happening in a production process can prevent improvement in material utilisation. However well designed a plant or machine may be, it must have sufficient instruments or indicators to signal its performance and make control possible. Economy in the provision of instruments can and often does lead to wasteful operation and heavy loss of material. Measurement of temperature, machine speed, rate of flow of materials and such factors is essential to high material utilisation.

In a recent report from the Institution of Production Engineers,* it was stated that in the engineering industries material utilisation is commonly as low as 70%. This leaves room for considerable improvement, but this improvement may have to be derived from basic study of engineering methods. At present it is regarded as economical to bring an article to approximate size and shape by casting, forging or rolling and to produce the finished article by machining away a substantial weight of metal. The engineers of the future may well regard this method as crude and wasteful, and signs of this transition of thought are already appearing. Likewise, in many process industries methods which formerly yielded 80% or 85% utilisation of material are steadily giving way to improved methods giving 90% to 95% efficiency and over.

In many industries it is practicable to reward the machine or process operative for achieving higher material utilisation. Work Study techniques may be employed to set bonus incentives for quality of work or efficient use of material. Such devices can be a powerful aid to improvement. They should be allied to thorough training and instruction and are no substitute for proper understanding by the operative of what is wanted and why it is wanted.

Our attack on material utilisation is therefore in several distinct phases. First is the recording of the facts followed by the analysis of them. Next comes

*"Material Utilisation in the Metalworking Industries", price 5/-.

the application of the remedy whether by change in materials, alteration in plant or process, establishment of better control or by more skilful operation. Finally, the improvements must be maintained.

MACHINES

British industry still needs more and better machines, though by now much of the gap in replacements created by the standstill of the War years has been filled. But machines and industrial equipment of all kinds are much more costly today, their prices being often two,three or four times the prewar levels. Moreover, the tax reliefs given on machines replaced make a smaller proportionate contribution to the cost of new machines because of rising prices. For these reasons there is a continuing need to exploit to the full our resources of plant and machinery. In considering this aspect we may conveniently include buildings and land.

Once more there must be proper records of machine performance if we are to make an effective improvement. Records kept on a regular basis showing operating time, output rate, down time or "outage" and the reasons in some detail are an indispensable preliminary action. Delays should be dealt with at once, but there should also be regular enquiries into the causes of delays so as to detect and deal with those items which recur. It is important to deal with the disease rather than the symptoms. Many companies have a once-weekly "Waiting Time Committee" which considers reports and analyses of all plant delays.

A frequent source of poor machine performance is inadequate supply of raw materials or components. Sometimes a machine operative has to fetch his own materials when it would pay to have a regular operator servicing several machines. Tooling or other subsidiary equipment may be faulty or wrongly timed. Maintenance may be spasmodic or organised only to deal with breakdowns as they occur. The operative may not be suitable for the task or may not be thoroughly instructed. Regular analysis of machine and plant performance leads to recognition of faults and provides a programme for action.

Here again, quality control techniques can be a valuable aid and their rapid extension during and since the War has no doubt made a notable contribution to higher utilisation of our resources of machines. As has been demonstrated in an earlier Paper, these techniques enable machine performance to be adjusted before defective work is produced and in this respect are an advance on inspection and control methods of the "post mortem" variety.

Planned maintenance can be a powerful aid to raising machine performance. There is not sufficient space in this Paper to develop this point in detail. Two comments may, however, be made. Firstly there is nothing complex or difficult about installing planned preventive maintenance. Where records are already good they can be made the basis of a rapid changeover. Secondly, there is nothing miraculous about planned maintenance; it is merely the application of forethought based on established experience. It can be likened to periodical visits to the dentist for minor attention, as compared with rare visits when decay has gone so far as to demand drastic remedy. And the comparison is also apt as to the time, trouble and money which can be saved.

Regular records of machine performance will often show in startling fashion the effect of short runs on a large variety of products. However efficiently machines or plant may perform when operating on short runs, the proportion of preparation time, changeover time and other delays must always be high. It is usually a simple matter to calculate the effect on costs and efficiencies of longer uninterrupted runs on fewer products. The comparison can be dramatic and the remedy is Simplification, about which a Paper has already been given.

Work Study methods, including the payment of incentives, can readily be used to improve machine utilisation. Incentives need not be restricted to the plant operatives but can be applied also to the maintenance and service operators with beneficial results all round. This work must be thorough, for nothing creates ill-feeling more easily than badly devised incentives schemes.

Much equipment of all kinds in Britain is operated on the single-shift system, often with the addition of expensive and burdensome overtime. Where equipment is costly, it will often pay to operate on a three-shift system and the savings will provide adequate reward for the inconvenience and dislocation caused to the operatives. Worked in this way plant wears out faster, but the higher rate of wear and tear is more than recouped. Shift working is particularly attractive in industries where plant design is rapidly changing and improving. Here the industrialist should aim to utilise his plant intensively so as to pay for wearing it out fast. This leads to a more rapid technical improvement and maintains competitive ability. An important gain is the elimination of the down-time, i.e., the shutting down each night and starting up each morning. There is evidence that much more plant in Britain could be operated on a shift system and in some industries this may well be the sole hope for remaining competitive with foreign industries based on cheap labour. Resistance to this change must be overcome and this is a task for management.

So much attention has been concentrated on machine performance that utilisation of buildings and land is often overlooked. Nevertheless, the cost of low utilisation of these resources can be great and is often concealed. Industrial land has a high value, more particularly in the manufacturing towns, and thorough use of the land of a factory is important. It is becoming a scarce commodity. A previous Paper has dealt with factory design, construction and lay-out, but a practical suggestion can be added about utilisation of land. In most factories it is not difficult to divide the site into areas on which different plants are located and different products made. This can be made the basis for an analysis of the earning capacity of the various areas expressed either in terms of £'s of value or £'s of net profit per square yard. There is no need for hair-splitting accuracy; all that is needed is a broad guide. The analysis will often

show that some parts of a factory site are yielding a good return while others show a low profitability. Such figures must be treated with reserve, but they can provide valuable extra pointers in a thoroughgoing analysis of the utilisation of resources.

One last remark may be added about the use of this class of resources. In Britain we are far too reluctant to scrap old plant and pull down old buildings. We are too prone to persuade ourselves that in this way we are using capital resources fully and effectively. More often we are wasting more than we save by incurring increased maintenance and repair cost. A sound financial policy of rapidly depreciating the values of fixed assets should be accompanied by a logical and ruthless policy of scrapping those assets as soon as they become out-of-date, or their upkeep costs begin to rise disproportionately. In this respect we have much to learn from the more advanced companies both here and in the United States.

Money

While there is general recognition of the need to manage our resources of Materials, Machines, and Men efficiently, there is not so lively an appreciation of the need and the opportunity to use money resources better. Managements are sometimes prone to think that if they employ their physical and human resources effectively, then money will cause no difficulty. Indeed one frequently encounters the attitude, particularly amongst technical and practical folk in industry, that methods of financial control are theoretical devices contrived by accountants, with no practical value and designed to be a nuisance to those whose task it is to concentrate on production. Another attitude, commonly met and a little less unenlightened, is that if the practical matters of production selling and distribution are looked after then money, which is merely a convenient unit of measurement of values, will look after itself. Both attitudes are wrong and managements must be disabused of such ideas if progress is to be made.

The essential first step, therefore, is to create in a company the climate in which techniques for control of money can operate effectively and with the helpful co-operation of all. It is useless to attempt to improve control if there is a tribal war between accountants and production management, between technical staff and costing clerks. Top management must make it a first duty to explain to all concerned why it is of the highest importance to obtain better utilisation of money resources and why it is in the interests of all to achieve that object. The conversion of the objectors consumes much time and patience, but is a necessary step and it should be done by persuasion rather than by compulsion. This does not mean that top management should display a half-hearted or flabby attitude. Firmness of purpose is not inconsistent with patient and thorough explanation of aims.

The theme of top management should be that they wish to plan the future of the company including its future profitability. Without such deliberate forethought it would not be possible to make systematic provision for the future and the company would merely drift in a haphazard manner. Management does not wish that to happen and therefore top management is estimating, usually for a year ahead, the likely values and costs of sales and the amount and total costs of production and distribution. Methods of financial control are therefore to be installed or improved in order to plan and control these factors. In this way the profit of the company, comprising the difference between total earnings and total expenses, can be estimated. Only by such measures (it is explained) can the future of the company be planned so as to provide for security stability and expansion. Only by such measures can top management assure its employees of reasonable working conditions and salaries and its shareholders of reasonable returns on their investment. And such measures are also in the interests of the customers in ensuring stable prices based on a coherent policy about profits.

Once top management has successfully explained this policy and won its acceptance, then the way is open for the more detailed application of method. This is a matter largely for detailed discussion between accountants, cost clerks, etc., and the factory and office staffs. Piecemeal experiment to establish suitable control techniques should precede frontal attack. This is not only sound psychology ; it is also good practical method. Difficulties and disagreements will occur and top management must restrain the urge to use the heavy hand on detailed matters best left to local argument and persistent infiltration. On the other hand, top management must be satisfied that there is co-operation at every link in the chain of authority and that there is a will to succeed.

Explanation having been successful, the next step must be to place responsibility. Factory management and supervision must not be left to think that control of money is a pipe-dream of the accountant. Rather should it be regarded as a necessary tool of management, just as useful as other techniques of control. Each shop-manager, supervisor or foreman should be as fully responsible for controlling the expenses of his section as he is for controlling materials, machines and men. This involves a good deal of teaching and training of supervisory staffs in the methods of control to be employed. Success can only come after the twin operations of explanation and placing of responsibility have been carried through.

Two main methods of control are so well known as to need little exposition. Budgets of sales and of all types of costs and expenses should ordinarily be made for one year ahead, divided preferably into convenient periods such as one month. Reports on performance should compare estimate (or budget) with actual performance and it is important that these reports are available as soon as possible after the end of the period. There should be prompt discussion of the reports period by period and department by department, so as to establish rapidly the reasons for surplus or deficit of performance against budget. Management at each level must insist on full explanation for discrepancies, while naturally concentrating on the more significant ones. At first there may be a tedious period when questions do not

receive prompt or clear answers and progress is very halting and slow. Top management must exercise patience at this time in the full confidence that in due course management at each level will grasp the new methods, realise their value as a tool of control and begin to apply them on a realistic basis. When this happens and performance is brought within the budget estimates, when credits begin to take the place of debts, then top management should remember to be generous in its praise.

Along with budgeting methods should go the application of Standard Cost methods. Similar stages of explanation, placing of responsibility and step-by-step application are again necessary and beneficial. The concept of a Standard Cost for a product is often seen at first as a somewhat unreal and imaginary device—as in fact it is. Day by day practice in the operation of standard costs is the best way to dispose of this impression.

In these ways opposition in the factory to schemes of financial control can be met and changed to acceptance. As time passes acceptance should gradually turn to enthusiasm and pride of achievement. Everything depends, in the long run, on the clarity of purpose, the powers of exposition and persuasion, and the patience and diplomacy of top management.

Space does not permit a detailed discussion of particular techniques for ensuring the effective utilisation of money resources. Some general comments may, however, be added. Since money is basically a convenient means of exchanging values created by the production of goods and services, it follows that money is effectively employed only when it moves. And to state the converse money is idle when it is static. Thus it should be a prime object of management to keep money moving and to avoid allowing it to stand idle and fallow. Simple as these broad statements may sound, they can be applied with considerable force and effect to the task of managing money in a business. For example, a factory management may regard a large stock of raw materials as a good investment and an assurance for continuity of output. But if the money locked up in that stock is regarded as static and idle instead of mobile and working, a different attitude is created and different action will follow. In the same way, methods for controlling and limiting the credit of customers are at root based on the concept of money, moving and active.

Control of the money resources of a business can have a powerful effect, not only in securing direct and rapid economies of operation but also in assisting the planning of the total resources of a company into the future.

MEN

The last category into which resources have been so arbitrarily divided is the most complex and important and it contains the greatest potential for improvement. There is so wide a difference between the best and the worst practices in utilising human resources that there is an evident scope for great advances. The present unsettled atmosphere in the relations between management and workers indicates that the ideal of a common purpose in industry has not yet been reached.

Man is a thinking creature and it is this fact which demands that we treat human resources differently from inanimate resources. Man's capacity to think and to rationalise has two important consequences. First, his mind must be led to accept whatever policies are to be pursued if his active co-operation is to be enlisted. Secondly, he is capable of far greater development than are other resources. Perhaps he is capable of development to an extent not yet generally visualised.

In the early part of the century there was great concentration on the purely mechanistic approach to securing human efficiency in the performance of work. The efforts of Taylor and Bedaux and many others were focussed largely on making man into an efficient work-machine. Latterly the importance of securing the understanding, sympathy and co-operation of workers in the policy and aims of management has been increasingly realised. These two aspects will be dealt with separately but briefly. More has been written on the first aspect than perhaps on any other management topic, while the second aspect is now accumulating its own store of research, experience and archives.

Probably the two most significant recent contributions to what has been termed the mechanistic aspect have been T.W.I. (training within industry) and the widening adoption of Work Study methods, together with all the variants of each not formally recognised under those titles.

Work Study has in recent times become a powerful and an effective tool of management in the drive for better utilisation of resources. Work Study can aid in improving the use of material resources and of plant equipment. But it is in the application of Work Study to the utilisation of human resources that its greatest contribution can be realised. Once more there has been a Paper devoted to this subject and no detailed treatment will be attempted here. But some comments may not be amiss about the ways in which Work Study may best be employed. Firstly, it should not be applied by inexperienced or unskilled persons for it is a technique demanding skill, practice and experience to achieve success without creating discord. In spite of this, the principles of Work Study are plain and simple to understand, not mysterious and esoteric. Workers to whom Work Study is to be applied will expect to understand the methods and it is management's task to create that understanding. Many firms have trained men's representatives in Work Study principles and methods and have found this a great assistance to understanding and acceptance.

It is now coming to be more generally realised that Work Study has a wider purpose than the devising of money incentives or rewards for work. But in suitable cases the logical extension of Work Study techniques of method improvement and measurement of work is the payment of incentives. Again, skill and experience of this work are essential and the risk of friction and discontent from faulty incentive application is considerable.

Training on the job by systematic techniques is now more widely practised than ever, but it is doubtful whether T.W.I. and such methods have yet been tried by a majority of British firms. The old practices of learning from a more experienced worker are still more general than methods based on the best known teaching and training principles. There is a great deal of help available, much of it without cost to the enquirer. It is a question worth consideration how to spread better training methods. It is also a question whether, with better methods, training need take so long and be so costly as it often is, notably in the longer apprenticeship schemes.

One plea may be made without attempting a detailed exposition of training methods. Effort should not concentrate solely on the better performance of work at the workplace. Training schemes should have some content of information about the relation of the worker's task to the work of the company as a whole and to the place and purpose of the company in the community. Many companies have achieved such a result with benefit to all.

Since the War, there has been a great growth in training schemes for all levels of management both within industry and at various specialised institutions. Training can bring considerable improvement in management performance and in the better utilisation of all resources at the disposal of management. Management training can have two directly beneficial effects. It can improve the performance of a manager in his own job, and it should also give him a better realisation of his task against the task of the company and the needs of the nation.

Companies are often shy of involving themselves in systematic management training because they fear it necessarily leads to the creation of a large and expensive training department. This need not happen, for there are many outside courses available for all types of management training from the supervisor to the man who is "knocking at the board-room door". Many of these courses are inexpensive in relation to what they can offer.

Alongside systematic training should go systematic assessment of staff and management. It is important to fit the square pegs so far as possible into the square holes and this is a problem demanding close study and regular consideration. There is little value in training a peg to be truly round if it is in a square hole! Here systematic Merit Rating has been employed with success by many companies. Merit Rating is an objective and logical method of assessing people in their performance on their jobs and in their suitability for those jobs. It can be employed to focus attention on strengths and weaknesses in staff and management and to indicate where improvements can be made. Merit Rating is not difficult to instal and the enthusiastic co-operation of the staff can readily be won.

The realisation has been growing in recent times that the greatest advances in utilisation of human resources in industry are likely to come from the development of full understanding between all ranks from top management to shop-floor. Man as a thinking creature must be led to comprehend the purpose of his daily work, to link his interest to that of his company, and to relate the work of his company to the task of the nation as a whole. This is an enormous challenge and we have as yet made no more than a beginning. In this field the industrialist has left too much to the politicians and has made too little effort to explain the aims and objects of industry. Signs are evident, however, of widening interest in the problem, particularly in the development in many firms of more effective means of joint consultation and in the provision of more and better information to employees about the affairs of the company. Industrial managements have here a considerable task and there are numerous obstacles to overcome.

Industry today inherits a poor social status and prestige. Much of this derives from prejudiced accounts of the social aspects of the Industrial Revolution based on the ethical standards of today rather than those of that period. Memories of the industrial depression of the inter-war years still warp our judgments in the very different circumstances of the present time. And there is still a great lack of understanding about the position of industry in a modern industrial society. Ignorance about the need, the purpose and the distribution of profits adds to the accumulated bias.

Some of this problem lies in the sphere of politicians, the leaders of industry and the trades unions. But every member of every management team in industry should be making his effort to dispel the miasma which has hung over industrial relations for so many years. Managements must have first of all a clear policy which they can relate to the current needs of the country. They must make efforts to explain this in simple terms and to have it understood by all — an exceedingly difficult thing to achieve. And by regular flow of information and by regular consultation they must enlist first, understanding, then stage by stage the full co-operation of all. Success in this task may well achieve gains in human effectiveness far transcending those possible in the other categories discussed above. This is perhaps the supreme challenge to management in industry today.

Conclusion

A sketchy analysis of a very wide field has been attempted and many gaps have necessarily been left. Comment has been concentrated largely on the measures which management can take to improve utilisation of resources, for it is the writer's belief that responsibility lies mainly with management. There are many things which Government, Trade and Employers' Associations and Trades Unions can do to help. But the main task lies with management in each factory in Britain. The scope for improvement and progress is very great — perhaps most of all in the field of human relations. Management has a great opportunity to contribute powerfully to the well-being of the country which depends more than ever on a prosperous and efficient industry.

INVESTING IN EDUCATION AND TRAINING

by A. D. BONHAM-CARTER

Mr. Bonham-Carter

Mr. Bonham-Carter joined Lever Brothers & Unilever Ltd. as a Management Trainee in 1929 and has had a varied career, having served with a number of associated companies in the Unilever organisation. He started as an assistant to the Sales Manager of Joseph Watson & Sons of Leeds and, after a few years as a Sales Manager in Bristol, he returned to Leeds as Sales Director of Watson & Gossage Ltd. in 1938.

During the war period he served in the U.K., Middle East and Italy in the 45th (Leeds Rifles) Royal Tank Regiment. On the cessation of hostilities he returned to Unilever as Commercial Officer of Personnel Division before taking over the Chairmanship of John Knight Ltd. of Silvertown. In 1950 he returned to Unilever House to be head of Personnel Division and in May 1953 he was appointed to the Board of Unilever Ltd.

Outside interests include Chairmanship of the Education Committee of the British Institute of Management; the Education Committee of the Federation of British Industries; the Department of Scientific and Industrial Research—Joint Committee on Human Relations; and the Appointments Board of the University of Nottingham.

THE general theme of this Exhibition and Conference is " Investing in Success " and previous Papers have been devoted to an examination of some of the tools by which that success might be achieved. But these tools are not enough in themselves : the skill of the operators and managers who are to use them must be equal to the increasing demands of improved techniques and methods, which have now reached a level which calls for a full share of the best brains and ability which the country has to offer. It was in appreciation of this that the Federation of British Industries organised two highly successful conferences between industry and the Universities and, only a few weeks ago, a third and equally successful conference between industry and the schools, both public and grammar.

On this last occasion, Sir Reginald Verdon Smith, in the course of an admirable opening address, suggested that industry to-day has a three-fold task—to maintain the stability, the strength and the prosperity of this country. He claimed that our stability, or ability to play a leading part in the world, depended on the success of our designers, our manufacturers and our salesmen ; that our strength, or ability to overcome the dangers of our geographical position and lack of physical resources, depended on the superior skill of our technical people; and that our prosperity, or the ability to maintain our policy of full employment, of social security and of a higher standard of living, depended on our level of production. His suggestion means that the whole future of this country depends primarily on the success of our industry. Sir Reginald is quite right and it is important to add that our industry can only be as successful as the men and women—managers and workpeople—are capable of making it.

It is our task to consider these men and women, managers and workpeople, under the heading " Investing in Education and Training."

The dictionary defines the word ' invest ' as " laying out money on ": ' education,' it says, means " intellectual training " and ' training ' is " bringing a person to a desired standard of efficiency." So the title of this Paper—" Investing in Education and Training "—is an invitation to consider the question of laying out money on intellectual training and bringing people to a desired standard of efficiency. In other words, we are invited to examine how we can set about the task of seeing that the operators and managers who are to use modern techniques and methods, will be able to do so to full advantage. If we can be sure of doing this we will probably

succeed, at the same time, in finding the small number of outstanding men and women who will keep the techniques and methods up-to-date too by their work in research and development.

There are still people in this country who answer the suggestion that education and training is the solution to a large part of our problems by saying that experience is the only sound way of learning and 'throwing them in at the deep end' is the best method. It is interesting to notice that the advocates of this method do not usually apply it to their own children, which in itself makes it possible to ignore the attitude, even though there may still be a few people who genuinely and sincerely believe it to be a proper one. This Paper is, therefore, written on the assumption that education and training must play a major part if we are to make use of modern techniques and methods, and our concern is what the country as a whole, and industry in particular, must do about it.

The solution of the problem can be made to sound quite simple. It is, surely, to ensure that in the first place every boy and girl is given the fullest education which his or her innate ability will merit: to provide, at the second stage, the appropriate basic vocational training to meet the demands of industry and other potential employers—the demands, in fact, of the country: and, finally, to see that there are opportunities of whatever further study is needed to build on the results of the first two stages, plus experience as it is accumulated after the man or woman has started working: some of this will be in the vocational field and some of it will be in other fields.

The Government's Policy

Generally speaking, this is what we are trying to do. The purpose of the Education Act of 1944 is to provide opportunities for education regardless of the financial position of the parents. The Government's policy in the field of technical education is aimed to meet the demands of industry and other employers, and the purpose of the Administrative Staff College, and many universities and technical colleges, is to provide various opportunities for development at later stages. But although much has been done in the last ten years, it cannot be denied that the position is far from satisfactory and we are a long way from achieving our goal. Let us examine it in more detail.

To achieve the first aim involves correct selection of the young people as they pass from the primary stage to the secondary and again as they reach the age for going on to the University. It involves the proper curricula, and the provision of the necessary facilities in terms of buildings, equipment and so on.

Most of this is primarily a matter for the educational authorities and experts, but industry is so vitally interested in the results that it would be quite wrong to pass it over as not being our affair. It must be left to those in charge of the young people to decide the degree of ability which they possess, but we are entitled to urge them to be diligent in seeking to perfect their methods of selection: it is quite possible that with the so-called "eleven plus" method and the amendments which have already been made to it, we have already found a method which is as good as any which can be devised. Infallibility is impossible, but it is reasonable and proper to urge the educational authorities to subject their methods constantly to examination and review. They have a difficult task and they are entitled to demand of us not merely sympathy and understanding but all the assistance which it is in our power to give them. At the moment there will be many who will think that the selection is not the weak point, but that too little is done for those who are not the most successful at this stage, i.e., those who are not destined for the Grammar Schools.

It is doubtful whether we can be of practical assistance in these early days, except in our capacity of parents. But the educational authorities are entitled to ask whether we can assist them later on. They are engaged in seeking to give to each individual young person the best education which he can use and their object for the most able of these young persons is to fit them for a university. Yet many of these who are judged to be fitted for a university education do not, in fact, get there. We must ask ourselves to what extent we in industry contribute to this. Full employment brings its problems and it is difficult to see how we can reconcile the demand for more workers with the need to hold all the right young people back for further education. As industry has "no unity," to quote Sir Reginald Verdon Smith, "no controlling authority, no singleness of purpose, and no common voice"—it seems inevitable that there will continue to be competition for the available labour and many young people will be attracted by good wages to start earning sooner than it is in their own and the country's long-term interest that they should do so. The public at large, and the education authorities in particular, are entitled to ask both sides of industry whether they are prepared to face up to this serious problem of the "early leaver."

It is a matter for both sides of industry. The Trades Unions have certainly moved in the right direction and, as a whole, do not object to allowing entry into a craft at later stages: but neither they, nor the employers, can avoid the question as to whether any apprenticeship scheme which starts at 15 and continues for five years is logical in a country where the education authorities are struggling to persuade the most able young people to stay on at school to 17 or 18 years of age, and go on to a University if they are fitted for it. Should, in fact, the student apprenticeship for the 18 or 19-year-old be given more backing by industry as a whole?

Nor is industry the cause of all the difficulties. There are still too many who are unable to take advantage of a University education, because the educational grants are insufficient after the means test has eaten into them. Is it too much to hope that some enlightened Chancellor will consider this matter realistically and do something to diminish this leakage of ability? Indeed, there is a strong case for abolishing this means test altogether, or at least amending it radically. It seems quite absurd that a man with a gross income of £2,000 can get virtually no grant for his children.

Then there is the problem of the curricula. Here again it is the education experts who must make the decision and find the solution to the conflicting

demands of specialisation and a general education. There can be little doubt that in the modern world a young man or woman without any scientific knowledge is at a disadvantage: on the other hand the average scientist who has devoted all his time to his specialised subject has difficulties, particularly of communication, which make him less than fully effective in his specialist field. The writer had occasion quite recently to visit a research centre where a group of most able young scientists are engaged on interesting and important work: their inability to communicate the results of their work was a standing joke between them and their leader, who was a strong advocate of a revision of the scientist's education in its earlier stages. The Government White Paper expands this point in its introduction and adds two more. " Technical education," it says, " must not be too narrowly vocational and too confined to one skill or trade. Swift change is the characteristic of our age so that a main purpose of the technical education of the future must be to teach boys and girls to be adaptable." Later on it reads, " Such subjects as economics, business management, wage systems and human relations must now be given more prominence." Finally, " All technical progress rests upon the common foundation of language, and more attention will have to be given to the teaching of good plain English, the use of which saves time and money and avoids trouble."

Now let us consider the facilities in terms of buildings, equipment and so on. Doing this involves making a rough survey of the supply and demand. It is impossible to assess the demand with any degree of accuracy, but we know from experience that it is urgent and enormous. If any evidence is needed it is surely enough to look at the position in this country alongside that in the United States or the Soviet Union. The unpalatable truth is that from 1951 until 1954 British Universities awarded in each year fewer degrees and diplomas in Technology than in the previous year and made no progress numerically with graduates in all science subjects. The United States certainly fell away from the huge numbers graduating in 1950, which was the peak created by the returning ex-Servicemen, but their total was still about 4½ times as great as ours. The Soviet Union went far ahead and turned out something in the region of 8 times as many science graduates as we did. It is true that our average quality is probably the highest of the three, although there seems to be little to choose between the standard of the best, but both these foreign countries are producing far more scientists per thousand of the population than we are. It is not pleasant to contemplate this in conjunction with the efforts now being made by the Soviet Union to capture markets in India and elsewhere.

The Demand for Technicians

Nor does the need finish with graduates; there is a corresponding demand for high-grade technicians. What of the supply both in terms of young people and the facilities for dealing with them? First let us look at the total numbers available. Here the picture for the next ten years is a reasonably encouraging one. Lord Simon of Wythenshawe, in his interesting and valuable memorandum on " Future Numbers of University Students," looks at this in two different ways. He assumes that the standards for acceptance will remain unaltered and that approximately the same proportion of sixth form leavers will go on to the Universities as at present; that is his first set of figures. He then makes a calculation as to what the position will be if there is an annual increase in the percentage of 5% of each age group staying on to enter the sixth form—there is evidence to suggest that this may happen for a few years and that we are, in fact, already having some success in reducing the leakage of early leavers; he looks at this higher figure for the sixth forms and then assumes that the same percentage as before will go on to the Universities. The result is an encouraging one, thanks to the so-called ' bulge '—the increase in births during the four years immediately following the end of the war.

The increase does not begin so far as the University age group is concerned until 1961 but during the following six years it is very big indeed as the following table shows. 1967 is the peak year.

	Percentage going to University constant		Percentage going to University increases 5% per annum	
1955	68,000	(=100)	68,000	(=100)
1961	70,000	103	81,000	119
1967	97,400	143	141,400	208

In addition to being able to draw some encouragement from these figures, we can conclude that we have a little breathing space in which to make our preparations and a big programme of capital expenditure in front of us. Once again it would not be profitable to attempt an accurate assessment of what the numbers involved will actually be, but it is reasonable to suggest that we must provide for an increase in student population of something between 60 and 100% and, if we sincerely believe in our policy of sending every young person to the University if he or she merits it, the nearer we get to the higher of these figures the better. We must, at least, ensure that anyone who is fit and willing to go on to University can be accepted. To go beyond 100% seems, at first sight, a proper aim but one is bound to have some doubts as to whether a continuing increase of 5% in the percentage of each age group going on to University is really a sound supposition.

These figures of the total numbers available are encouraging. Now let us look at the balance between the arts and the sciences.

In the sixth form at the grammar schools, some 60% are reading science subjects; there are some, and among them can be numbered a proportion of the best-known schools, where this figure is up to 80% and if we assume that there is no change in the curriculum, it would be unwise to hope that this higher figure might be increased. But in the absence of changes which might lead to a more general education for all, enabling specialisation to develop later, we can hope for a small increase in the potential scientists from this group of schools. At the direct

grant schools, the present position is that the sixth forms are equally divided between the arts and sciences, and in the public schools the proportion is in the region of 40;60 in favour of the arts. Both the direct grant and the public schools have shown readiness to face up to the situation and the fund subscribed by industry, thanks largely to the initial efforts of a small group headed by Mr. A. H. Wilson, F.R.S., Managing Director of Courtaulds, will enable them to make considerable progress in that direction.

The technical and modern schools take, jointly, about four out of every five young people for their secondary education so they too have an important part to play. These schools have shown that they can do a fine job of work but the country is not yet making full use of them. It is most unfortunate that the largely political issue—a type of issue which should never affect education—seems to have had this effect. The division of opinion about comprehensive schools seems to be strangling development, particularly of secondary technical schools.

Finally, there are the technical colleges. They are about 500 in number and cover a very wide field in technology. It is estimated that slightly more than two million students attend these colleges, most of them on a part-time basis. Through them students take and reach Higher National Certificate and London University degree standard. Many of them have come into being because of local industry and have developed with the help and encouragement of industry. The importance of the part which they are playing already cannot be over-emphasised and this importance is likely to increase very considerably in the next few years.

It is not the main purpose of this Paper to make a detailed and exhaustive survey of education in this country. Our task is to examine how we can see to it that the people in industry can make full use of modern techniques and methods. So far, you have been asked to accept that education and training hold the solution to this vital problem and that this country's continued existence as a world leader—to say nothing of the standard of living of every citizen—depends on a much more energetic pursuit of our aim to give every boy and girl, young man and young woman, as much education as their intelligence will allow them to absorb.

It has been suggested that while the decisions as to how this can best be done at school, college and University, must be a matter for the educational authorities to decide, it is the responsibility of every adult person as a citizen, as a parent, and also as an employer or industrialist. We have taken a brief look at the size of the task and at some of the existing facilities for dealing with it, and we can turn our attention to the present plans. We shall consider finally what special action, if any, is required from industry.

So far as Universities are concerned, the University Grants Committee is going ahead with plans for expansion at the Imperial College of Science and at four other Universities—Birmingham, Leeds, Newcastle and Sheffield. The first of these—at the Imperial College—will cost £15 million and will increase the student body by nearly 100% to 3,000; the others are in the chemistry departments. The chemical engineering schools at Birmingham, Cambridge and Manchester and the engineering schools at Bristol, Glasgow, Manchester, Newcastle and Southampton—are all scheduled for expansion and projects in specialist fields are planned elsewhere too. We are promised further developments which will be started after 1957.

All this we are told in the Government White Paper on Technical Education. Government White Papers are not propaganda and one does not expect them to be inspiring documents. Many, however, may feel disappointed at the lack of an apparent sense of urgency and imagination coming through it. Does it, one asks, match Sir Winston Churchill's feeling, when after comparing us with Russia, he said 'We must do more?' Will it be enough to accept the present arrangements and multiply them? Or does one detect the same spirit as was seen in the Barlow Report of 1946 which, admirable and effective document though it was, failed to grasp the nettle really firmly and budgeted for a deficit of 26,000 scientists?

It is in the technical colleges that the Government's plans are most ambitious. The proposal is to raise the capacity for advanced courses by about 50% to 15,000. This is worthy of the closest attention of industry, particularly as the success of the proposal depends on the co-operation of industry.

Sandwich Courses

Much faith is placed in the development of sandwich courses which last four or five years and involve alternate periods, usually of three to six months, of theoretical education in a technical college and practical training and experience in industry. The idea behind them is that, as technology becomes increasingly complex, the strain of qualifying by evening classes alone is too great and too prolonged. That idea is one to which many industrialists will subscribe and they will also agree that there will always be people who for various reasons will wish to continue their studies by the part-time method. Existing plans cover several industries—engineering, chemical and building among them—and others are contemplated. Their aim is to prepare students for the Higher National Diploma which, in the engineering field, can lead to membership of a professional institute. Not all sandwich courses aim so high and the shorter ones are of great value in meeting specialist needs in various industries, but the more senior ones can fulfil a vital purpose by developing those people who, perhaps, lack the full qualities to take advantage of a University yet can play a big part as practical technologists. The need for such training in industry is great.

Without going into further details, it is obvious that the operation of this plan and its success is as much in the hands of industry as it is of the local education authorities. In the first place, industry must show willingness to grant the necessary release: secondly, if full benefit is to be obtained, the factory training must be co-ordinated with the college instruction; thirdly, industry will surely have to be

prepared to lend the assistance of its experienced managers and specialists as lecturers and perhaps industry can also help by participating in the governing bodies of technical colleges, by giving facilities for research, by endowing research fellowships, scholarships, and by giving college staffs opportunities for consultancy work.

The Government White Paper encourages industry to follow the lead to assist students by paying the college fees and the same wages as would be earned if the student were working in the factory. Opinions on this point are likely to be divided. So far as fees and state grants go, some argue that all education is a matter for the State and include in that term the technical colleges: others argue that all technical training is a matter for industry and there is no reason, for instance, why the country retailer should be expected to pay for the training of the technologist working in the factory in the town at the other side of the county. In the matter of wages, the question is presumably one of whether anyone should be paid while he is not actually doing a job of work, and whether it is right that industry should carry the extra cost.

The correct decision on fees and so on is, perhaps, more difficult to decide than the one on wages as it is unlikely that the student himself will have to bear the cost of the fees, and so long as there is no delaying dispute over the matter, it may be better to express no view here: whichever way it is eventually decided, opinions will continue to be divided. But it is important that progress in getting the courses well established should not be hampered by the division. So far as wages go, the issue seems more clear: in times of full employment, no one cannot afford to lose good men of the kind who ought to be doing this further study. Unless wages or at least some financial assistance is forthcoming while they are at technical college, the best men are likely to go elsewhere—to employers who will give them that help.

It must not be thought that the Government's plans are only concerned with sandwich courses for technologists—advanced courses, that means. Technicians and craftsmen must be found to support the technologists and graduates. Here again, the facilities for their education depend on industry's willingness to co-operate mainly by granting day-release.

This scheme is one to be welcomed and, whatever opinions may be on some of the details, industry will do well to see that it is a success by entering into whole-hearted co-operation with the local education authorities. Differences over details can be worked out later. Nevertheless, one cannot help wondering if the Government has shown enough of a sense of urgency in this. The education of technologists is a matter of national importance and the establishment of a " Technical Colleges Grants Committee " might have been a wise move: such a body would have provided the sort of boost which would help technical colleges and at the same time provide a means of a reasonable degree of central control and co-ordination.

So far we have been concerned with bringing people up to the required standard in the use of what may be called the " tools of industry " and, while the acute shortage has caused us to lay particular stress on scientists and technologists and their development in various specialised fields, it does not mean that we can overlook the other tools—accountancy, buying, marketing, transport and so on. In each one of these fields there are vital parts to be played and the need for men of better education is as great as in the production side: for these people too, just as much as for the others, there is a need for experience in the use and development of their knowledge. To see that this experience is given an essential part of training and responsibility for it rests on the shoulders of management, starting at the very top. Every single manager and supervisor has this responsibility —it is part of his job and he cannot push it aside as something to be considered " next week—when he is not so busy " or to be left to the Training Officer in those larger concerns which happen to have such a position.

But what of management itself? Is there anything which industry can and should do to train managers? What, first of all, is management?

Lord Wavell, whom history may yet judge to have been the greatest general thrown up by the Second World War, thought that administration was the real crux of generalship. If you can agree that management and generalship are very similar—even if you cannot accept that they are the same thing —then management ability must depend to a large extent on ability to administer.

Sir Hector Hetherington once described the task of management as being ' to provide the conditions under which the work of a team can come to good effect in the achievement of some co-operative purpose.' That, surely, is getting us very close to administration again.

Without entering into any discussion as to the exact definition of administration or of management it is fair to say that they represent the responsibility of bringing together the tools or skills mentioned in the earlier part of this Paper and welding them into an effective whole.

Facing the Difficulties

This task of management has become more difficult and more complex in recent years. There are many reasons why this is so but it is worth mentioning one or two of them in particular. The very matter which we have been considering is, perhaps, the most important—that is, education. A policy of general education means that you expect each individual man and woman to use his intelligence to the full—and that means you expect him or her to think, to ask questions: and to contribute; the age of ' you are not paid to think ' has gone. Managing a team of thinking individuals is more of a test than managing a group who will do as they are told without question. Then, too, there is our policy of full employment which means that the threat of dismissal—fear—cannot be used as an incentive to effort. Fear is an easy weapon to use in the hands of an unscrupulous leader but, quite apart from the ethics, it is not effective in a time of full employment and any alternative is more difficult to use and calls for better and more intelligent management.

But however difficult the task of management may be, industry must find the people to do it. No orchestra can perform without a conductor however well trained the musicians.

The first step is, once again, a matter of selection, because no amount of education and training can make a manager out of a man who lacks the necessary qualities. Any attempt to define these qualities would involve us in a long and inconclusive argument, but it is worth suggesting that the way in which intelligence is used may be even more important than the degree of intelligence possessed—assuming it can be measured, and the ability to win the confidence of subordinates, equals and superiors may be more important still. We may run the risk ,as a result of the development of our education policy, of attaching too much importance to academic distinction and too little to character, yet it is hardly possible to exaggerate the importance of making the right selection for management; mistakes are costly.

The Problem of Training

Once the selection has been made, there is the problem of training. This is a responsibility for the experienced managers—they are the people who must see that at all times those junior and responsible to them are given every opportunity and encouragement to develop fully.

Several examples of this come to mind—two will illustrate the point adequately. Some years ago the writer started on his industrial career in a factory in Lancashire and was launched on a 12 months' programme which (combined with theoretical study of the tools of his particular industry) was designed to put him through each operating department in the proper chronological order. There was nothing unusual in that. What was unusual was that the Managing Director, despite the calls on his time from his duties as head of a large company, found it possible to see each one of his young men who had been selected for management and devote a good hour or more to them individually at frequent intervals. It was an ordeal for the young men, but not one of them came out of that interview without having learned a great deal and without a feeling that he mattered, which gave him an enthusiasm and determination about the future. But not the least important result of those interviews was the fact that, as the Managing Director set the example, the other managers down the chain of command all regarded the training of the young men under them as part of their daily task.

The other example comes from Malaya where, to meet the growing feelings of nationalism, it is essential to train men of the country to take positions of responsibility—and it is necessary to do it energetically. In this case, the Managing Director has formed small committees covering the various sides of the business and the young Malayans sit on the appropriate committee as participating members. The committees do not take the final decisions, but by setting them up the Managing Director has given these young men the chance of learning the management of the business, of developing their knowledge and confidence, and at the same time has impressed on his senior colleagues the need for them to regard this responsibility for training as of paramount importance.

Every programme of training for management must be tailor-made for the individual concerned. It may well be that even in a large concern, where there are many young people to be developed and trained on many sides of the business, all programmes will have much in common, but the object is to develop an individual and that means individual attention akin to the tutor system of some of the Universities. The programme may need to include further study of the tools of industry and involve part-time release, it will certainly require basic training in the practical application of those tools in the appropriate side of the industry and also the opportunity of broadening knowledge and experience in the other sides of the business.

The Army provides a good example in the way it approaches the task of training its officers. After careful selection the young officer is given a hard period of basic training on the barrack square, on the ranges, in the classroom and so on—he then joins his regiment and spends some years in becoming an expert in his arm of the service—then, as he gets up the ladder of promotion, he is given the opportunity of equipping himself for higher command by going to the Staff College and learning about other arms of the service and their functions. It is a continuing process and, broadly, the development of a manager in industry calls for similar treatment.

In the United States, the Universities play a bigger part in the training of managers than do the Universities in this country. It is unlikely that British Universities will introduce a first degree course in Management subjects but they have made a start in post-graduate work in this field and are likely to develop on those lines; it is to be hoped that they will do so as they have much to contribute. In addition to the facilities which the Universities are beginning to offer there are other external courses available for managers, the best known being at the Administrative Staff College at Henley. Probably the greatest value of these courses does not lie in the subjects which they cover so much as in the opportunity which they afford of thinking about a job in a new light and in conjunction with a group of contemporaries from other industries and walks of life. It is a process of self-examination aided by other people with different experience. The whole idea is still a new one so far as industry is concerned and there are many, particularly among the hundreds of smaller employers who, in total, make such a valuable contribution to the country's prosperity, who feel that these things are too expensive in time and money to be worth while. The answer to this line of argument is surely that if the end result is a better manager then it can never be too expensive, because nothing less than the best will be good enough.

Enough has been said to indicate the size and scope of this whole question of " Investing in Education and Training." That the investment is necessary to the very existence of this country can hardly be disputed—industry must have a full share of the best ability

and must make full use of that ability, otherwise it will lose the battle with its world competitors and that means the end of this country as a first-class influence and power and as a leader in standards of living.

The responsibility for finding the ways and means of making full use of the best ability does not lie only with Government and an attitude of ' The responsibility is not mine ' is a criminal one—criminal because it is suicidal for this generation and murderous for the generations to come. Active co-operation is required of a large number of people—parents, schoolmasters, local education authorities and industry among them. Together they must see that every boy and girl, every young man and woman, is given the opportunity to benefit from the best education and the best training which his or her natural gifts permit.

It would be idle to pretend that the investment is anything but a heavy one: indeed a true cost which would include the time of senior managers is tremendous. But the question is whether it is a proper charge on the running of industry. Putting it alongside the issues at stake there can only be one conclusion and, although it is natural and proper that there should be discussion as to what proportion industry should take directly to itself, such discussion must not be permitted to cloud the issue. The development itself must go ahead and with all speed. Industry must face the problem in a realistic manner—politics cannot be avoided and the demand for a reduction in Government spending may result in a challenge to industry to act more and more for itself. Indeed, the Government has committed itself to a large programme of capital expenditure on education and the challenge is already here. It is up to everyone who has the future of the country and British industry at heart to see that this is only the beginning and that challenge is taken up wholeheartedly and without delay.

SESSION XVI

INVESTING IN BETTER HUMAN RELATIONS

by F. HAYDAY

Mr. Hayday is National Industrial Officer, National Union of General and Municipal Workers. Responsible for Trade Union negotiations in various industries. Elected Midland District Organiser 1933. National Industrial Officer 1946. Member of the General Council of the T.U.C. from 1950. Secretary T.U.Side N.J.I.C. for the Gas Industry. Travelled extensively in the U.S.A. in 1952 studying Industrial Relations Problems in American Gas Industry. Member of the International Federation of Public Service Unions. Member of Joint Committee on Human Relations of the D.S.I.R. Member of Advisory Committee on Radioactive Substances.

Mr. Hayday

THE increasing attention paid in recent years to human relations in industry arises from the need to obtain the best possible utilisation of manpower in a time of full employment, by removing causes for friction that tend to lead to an interruption of work, and by encouraging methods and means that will secure the co-operation of workpeople to the mutual benefit of themselves, employers and the Nation as a whole. It is not a new problem and much has been said and written on human relations in industry in all its many aspects and from widely differing viewpoints.

Improved human relations in industry should be an end in itself and it is our concern, employers and trades unions alike, whether there be full employment or unemployment. As a contribution to more efficient working the value of good human relations is unquestioned and anything we can do to bring about better relationships is bound to be reflected in our industrial productivity.

In recent years, new definitions as to what we mean by human relations in industry have crept into our vocabulary and whilst noting the difference between the definition "Industrial Relations" as being concerned with relations between organisations of employers and organisations of workpeople, and " Human Relations in Industry " as relations between management and their workpeople as individuals, I do not subscribe to the view that one can be divorced from the other.

The developments over the last quarter of a century in our industrial life have firmly established our collective bargaining system and have brought about considerable change in traditional attitudes between employers and trades unions at all levels. Union aims as expressed in an extract from my own Union Rules " to promote the social, moral and intellectual interests of its members, to obtain and maintain for them equitable rates of wages and reasonable hours

and conditions of labour" have been pursued through the Whitley Council machinery and, to me, any measures involving the study of the individual at work are a logical outcome of the constantly evolving industrial pattern. It is against this background that I approach this subject from the viewpoint of a trade union official of a general workers' union and is based on experience and knowledge gained in many industries.

The Role of the Research Worker

Everyone accepts the importance of scientific study of materials, plant layout, machinery and equipment in order to achieve greater efficiency, and the role of the scientist in these matters is well understood. He can predict with accuracy on performance and capacity, but in the field of human relations the value of the social scientist has yet to be proven.

People are "human beings" and however knowledgeable we may think ourselves about their behaviour at times, their actions and attitudes are unpredictable. We cannot hope to rid ourselves of all industrial conflict and to me it is more important that we have an awareness of what tends to produce conflict in order that we may avoid it arising, or know how best to deal with it when it does.

In the past many studies have been conducted from the viewpoint of the employer as to how best the employer can get the most out of his employees in the interest of his own business success. Many of these investigations have tended to render trade unionists sceptical of the assistance that can be derived from research into social problems in industry.

The research work fostered by the Department of Scientific and Industrial Research since 1953 shows promise of contributing knowledge of these questions, but in my view some research workers labour under a considerable handicap in putting their ideas to industry. I have found no difficulty in sitting round a table discussing labour relations questions with employers and management as we converse in the same language of industry, but very often I have been considerably irritated and confused by the language and descriptions used by social scientists when talking about their investigations in the factories and workshops. I would suggest that research workers pay particular attention to the presentation of their findings, otherwise some of the information contained in their reports will never get the close attention it deserves.

Research into these human problems may be initiated from many sources such as the employer, the research organisation or Government-sponsored bodies, but in all this we are apt to forget the most appropriate machinery for this purpose, namely, the Joint Industrial Council at National or Area level, where agreement can be secured between the trades unions and employers on the kind of research projects undertaken, and the study of ways and means of applying the results of such research in their own industry. By this method we could ensure a joint examination instead of a one-sided one and we could do much to effect co-operation between management and men in an objective approach and study of the factors involved.

Research into these difficult human relation matters, therefore, must be promoted with the requirements of the management and the needs of the employee taken fully into account, and this involves acceptance and recognition of the part to be played by the employee's trade union in taking care of his interests.

As a change from the usual scientific investigation which often concentrates on one particular feature or facet of human behaviour in industry, I would like to see a different kind of approach. There are many individual firms and industries which have an excellent labour relations record over the past 25 years or more and they range from staunch free enterprise firms to the public services and nationalised industries. Why not examine the management and employee relationships in these firms in an endeavour to show what human factors have contributed most towards this happy state of affairs ?

The Individual and the Group

The relationship between the individual, the works group with which he is associated, and management is a very complex one. It is in this sphere that research can give us the greatest assistance in providing us with knowledge of those human factors involved in the very difficult circumstances that arise from time to time, for they are not always due to happenings inside the works or factory itself. You cannot seal off what happens outside in the wider social circle from what goes on within the factory. Factory life is a communal life and the individual worker brings many influences to bear on his everyday work that are known and felt by him in his life outside his place of employment. He is working at his job for a variety of reasons, some understood and some he is only vaguely conscious of. Primarily he follows his employment for economic reasons. His main concern is to earn a livelihood and maintain his family at a reasonable living standard. Like his fellows he is subject to the same hopes and fears, security and insecurity ; he has friendships and ties within the factory and outside ; in short, he shares common aspirations and beliefs with those of his work mates, and it gives him an opportunity to express his personality and enjoy the social atmosphere with his own particular works group. This influence can be very strong and is reflected in the individual and group attitudes to all forms of management policy. It follows, therefore, that the individual and the group in surveying their own situation, their human objectives and ambitions, place considerable faith in their own representatives on the shop floor, in the collective bargaining machinery and in all other forms of management and employee relations.

Whilst it would be foolish to deny the existence of an individual relationship between management and employee, it is important to remind ourselves that in productive industry work is organised on a team or group basis and the measures that we should consider are those that bring a response from the group rather than the individual. In a Paper published recently

by Mr. H. N. Stevenson of Glasgow University, information is given on a research project aimed at shedding light on the formation, maintenance and transmission of group ideas conducted in a printing works, in a hydro-electric construction camp, and in a large central office. The research was concerned with the effect rewards and penalties have on group behaviour, and under a paragraph headed " Relations between Sanctions and Group Aims " there appears this extract :-

> " The difference between the kind of sanctions applied by Management on the one hand and Unions and Work Groups on the other was found to be closely related to the kind of behaviour which each side seeks to establish. Management offers material rewards and penalties which are designed to encourage individual effort and initiative. At the management level a man is on his own, a competitor for promotion among his peers, and for this reason he can be appealed to as an individual. At the worker level, however, this is not the case. Trade Union and Work Group rewards and penalties include social sanctions of approval or ostracism which are designed to penalise individuality and encourage group loyality. The one policy is designed to pull workers out of Work Groups and on to the promotion ladder ; the other is designed to prevent Management from being able to divide and rule through setting one worker in competition against another. Each side regards the other's attitude as " bloody-minded " because *in practice* neither side makes a serious attempt to see the other's point of view and to adjust policies accordingly."

This attitude is not uncommon in industry and it can be found where there are no satisfactory provisions for real examination through consultative machinery. We must not minimise the fact that there will be occasions when there is a conflict of interest, but more often than not it can be demonstrated that there is a mutual advantage to be gained in a frank exchange of views.

Joint Consultative Committees

Our machinery for collective bargaining successfully operating in the vast majority of industries today in the form of Joint Industrial Councils is the direct result of the recommendations of the Whitley Committee, based on the experiences of the 1914/18 War, and has been responsible for the progressive improvement in industrial relations since the 1920's. It is not my intention or purpose to deal with matters concerned with the negotiation of terms and conditions of employment, but to refer to the effect this machinery has on joint consultation at factory level, for at the same time this form of machinery was recommended for dealing with terms and conditions of employment at National and Area level the Whitley Committee expressed the view that :

" A permanent improvement in the relationships between employers and employed must be founded upon something other than a cash basis. What is wanted is that the workpeople should have a greater opportunity of participating in the discussion about and the adjustment of those parts of industry by which they are most affected."

A number of subjects was specified by the Committee as being suitable for consideration by Joint Committees of employers and workers at National Regional and local level. Among the objects suggested were the following :-

1. The better utilisation of knowledge and experience of the workpeople.
2. Means for securing to the workpeople a greater share in and responsibility for the determination and observance of their working conditions.
3. Consideration of the workpeople's view in relation to improvements of processes, machinery, organisation, and industrial experiments.

There were a number of other suggestions in this Report, including the negotiation of wages and avoidance of disputes, which now form part of the recognised function of the National J.I.C.s.

The close link-up between national and regional machinery and works committees in individual factories as visualised by the Whitley Committee was never realised. Indeed the very existence of the bargaining machinery itself being voluntary in character and dependent upon the goodwill and co-operation of the Employers and the Trade Unions was threatened by the adverse economic conditions in the 1920's and the resulting successive wage reductions culminating in the 1926 strike to be followed by the depressed early 1930's. The Unions in the negotiating machinery were continuously engaged in resisting wage reductions and endeavouring to preserve the living standards of their members. It was impossible in such conditions to expect the introduction of consultative committees at factory level. After the Second World War many of the joint production committees which had performed a really valuable service in stimulating industrial effort were allowed to lapse, under the mistaken impression that the need had ceased with the return to peace-time conditions. The post-war task of achieving a balance of trade depended in no small degree on the human factor in industry. In January, 1947, a statement on economic considerations affecting relations between employers and workers was laid before Parliament, stressing the need for " a considerable and sustained increase in the production of goods of all kinds ". It was for all concerned with industrial production, the statement urged, to apply themselves to this task of improved efficiency and output in the realisation that the common good of the country as a whole depended very considerably upon their efforts. The renewal and extension of machinery for joint consultation between management and workpeople on production problems was suggested. The National Joint Advisory Council, composed of representatives of the British Employers' Confederation and the Trades Union Congress, agreed to recommend to their constituent organisations the setting up of joint consultative machinery, where it did not already exist, for the regular exchange of views between employers and workers on production

questions, subject to the following general rules :-

(a) that such machinery would be purely voluntary and advisory in character;

(b) that it would not deal with questions relating to terms and conditions of employment which are normally dealt with through the ordinary machinery of joint negotiation;

(c) that it would be left to each industry through its ordinary negotiation arrangements to adjust the form of machinery best suited to its own particular circumstances, and to decide in particular whether such machinery could best be established at the factory level or cover a wider area.

Joint Consultative Committees are a permanent feature in our industrial life and as such close attention must be paid to their functioning.

If we survey the machinery for joint consultation at National and Regional level and examine the kind of questions under discussion we at once realise that the value of these discussions is considerably diminished unless there is effective co-operation at factory level, and whilst there are a number of ways of achieving this the successful operation of Joint Consultative Committees must be considered foremost. I do not wish to elaborate on the machinery at factory level, except to say that it varies in detail according to the size of the factory and the type of industry. The basic provisions are similar and there are many publications describing the machinery especially in the nationalised industries.

My concern is with ' joint consultation ' as an idea; our understanding of the term, and what we expect it to achieve. It is obvious that this general question has been debated time and time again in many spheres and particularly in trade union branch meetings, so far as I am concerned. It would be foolish to suppose that there is one collective mind or opinion on the subject. We may differ on a number of aspects regarding the practice of joint consultation, but there is a wide appreciation of the need for joint consultation and an increasing acceptance of the responsibility that this brings.

The successful operation and complete fulfilment of the aims and objects of these committees must not be expected immediately. In my opinion, we are only at the very beginning and much has to be done in creating the right atmosphere and climate of opinion before satisfactory and steady progress can be accomplished. There has to be an acceptance by all concerned of the willingness to work together for the common good of the industry and it is essential that both management and men are represented by people who are prepared to make it a success and are competent to do so. In many industries we are fortunate in having established sound relationships between management and men and, with this background, the introduction of joint consultative committees can find suitable conditions in which to flourish.

I firmly believe that joint consultative committees operating in the right spirit can achieve great things in industry and eventually bring about a marked step forward and a new relationship between management and men. What we seek to establish is a co-operative team of managers, technicians, and workmen, each knowing the part they are expected to play and mindful of the role of each other. What we have to guard against in the working of these committees is that the members serving on them do not attempt to represent ' sides ', or that questions under discussion can be divided into management questions and workers' questions, with one side proposing and the other side opposing. What we want to see is a broad approach to any problem in hand and an examination on its merits realising that there is a common interest in the success of the industry. These conditions of mutual confidence will not develop in all cases by themselves, they will need to be encouraged and stimulated if joint consultation is to be the success it can be.

A study of Joint Consultative Committees will show the varying stages of development. A large number of matters under discussion are relative to welfare questions such as ventilation, canteen facilities, washing accommodation, safety precautions, etc. All these questions are very necessary and will form a permanent part of the functions of the committees, but it is encouraging to note the increasing attention given to matters relating to materials, plant, and the efficient working of the various operations carried out. There is plenty of interesting information showing that committees are considering policy, development planning, redundancy, extensions, and many other vital questions.

In its fullest sense joint consultation should mean that no important change in production methods is instituted without prior consultation. There must be a genuine effort to get the workers' views and opinions and profit by them. The employees should have the fullest details presented to them in an understandable fashion, not only relating to production processes, but costings, finances, details of profits and their distribution. The right of the employee to this knowledge should be unquestioned, as his whole working life is governed by these factors.

There is a sincere desire on the part of employees to contribute their ideas based upon experience and knowledge of the job. It may be that on occasions the men are critical of the actions of management and voice these criticisms in strong terms, but this should not be unduly resented. It is far better that honest criticism should be voiced in front of management at the consultative committee and not spoken behind their backs in the works. Management should welcome every opportunity of defending or explaining their actions, as it is only by free discussion that the employees can get an insight into some of the problems of management and are better able to appreciate the difficulties sometimes involved.

The whole aim, purpose, and direction of consultative committees should be to bring closer together management and workers in a combined effort for the common good. The problems discussed should be looked upon as common problems and as such should be jointly tackled in discussion to find the right answer. The efficient functioning of these committees varies considerably and it is essential that we pay particular attention to defects in their operation and

try to remedy them. Management and workers should not be content with going through the mere formalities of consultation; they should have sufficient vision to see what they can accomplish and they should be prepared to take all steps necessary to see that they do the job for which they were intended. Most difficulties spring from the attitude of mind brought to the conference table, and many from a clash of personalities and some are due to the incompetence of both management and men.

There are capable and progressive representatives of management who have cultivated an excellent relationship on these committees and this is reflected in the cordial atmosphere and co-operative spirit in the works. In others it is apparent that they have reservations and doubts as to the value to be obtained from the activities of joint consultative committees. To some it would appear that they are surrendering part of the functions of management, or that their authority is threatened if they are to be subject to the criticism of subordinates. I have heard management complain that many problems are too technical and complex for the workers' reprsentatives to understand them. To these objections I would emphasise that consultative committees are advisory and the responsibility for making final decisions rests with the management. It is preferable in making these decisions to know that you have come to them after everyone concerned has been consulted, and has had an opportunity of expressing his view and contributing his knowledge to the making of that decision. That is the way to real co-operation. There is an obligation on management to put over difficult and complex problems in understandable terms and it may well be that at times the workers' representatives can only express a limited view, but this very often can be of considerable value.

My own trade union has given careful and detailed consideration as to how best we can assist the smooth and efficient working of these committees. Many of our members actively participate and are making an intelligent and live contribution. There are many more who desire to play an active part and are availing themselves of the opportunity to add to their knowledge and equip themselves so to do.

Some five years ago, my union entered into an arrangement with fourteen technical colleges in different parts of the country whereby we provide a one-month full time course on Industrial Relations and associated subjects for the benefit of our members. To date, over 1,700 have completed this study course at a cost to the Union of approximately £50 per student. The demand for these courses is constant and the type of student coming forward is of good standard. The syllabus taught at these colleges has been drawn up after consultation between the Union and the Principals and gives prominence to the principles and practice of joint consultation. Last year those members who had attended earlier courses were invited, after having been back in industry for a reasonable period, to comment on the value and effectiveness of such courses. We have examined over 400 replies which represents a 75% response to the enquiry. The replies in general emphasised the great value of this form of training, especially in regard to joint consultation and increased productivity. Quite a number of members stated that the training had given them greater confidence in tackling their duties as shop stewards and committee members, whilst others wrote saying that the members they represent had more confidence in them in the knowledge that they were trained and capable of dealing with works problems.

We must not neglect any opportunity to propagate and proclaim the benefits to be derived from successful joint consultation and to remove any doubts and misunderstanding as to its purpose. There are men who fail to understand why they should help to raise the efficiency in their industry, feeling that it is no concern of theirs, or that the only results might be to put themselves out of a job or increase profits. They have to be assured that in any change involving transfer of labour the utmost will be done to protect their livelihood. I think the great majority of workpeople realise that only an efficient and prosperous industry is capable of maintaining and improving the wages and conditions of its employees.

Personnel Policy, Foremen and Supervisors

With the growth of an enterprise the problems of human relationships within a firm multiply and there is an awareness of the need for a separate department of management to cope with these problems. In a small firm management and men form a community in close daily touch with each other, knowing and understanding each other's work problems, and with an appreciation of their obligations to each other. As a firm grows in size it is not possible to maintain this same kind of contact and the organisation has to be departmentalised and responsibility and functions delegated to separate managers.

According to the size of the firm and the aims and policy of management, the functions devolving upon the Personnel Department differ widely in scope and practice. Successful operation of the Personnel Department calls for most careful staffing with people who have the knowledge and skills to deal with labour problems and who can bring a human outlook to bear on their daily tasks. There must be a clearly defined authority and status accorded to the Personnel Department within the management structure and it should rank equal with any other form of management function. In many ways it may be said that in discharging its duties and responsibilities to employees, the Personnel Department has one of the most difficult parts to play in managerial responsibility. It has to counsel and advise all other departments on labour problems, and at the same time avoid arousing jealousy and misunderstanding with those departments regarding the exercise of authority. It has to implement and interpret policy to the employees whilst demonstrating that justice is being done, and it must establish and retain the confidence of the trade union representatives.

There are some aspects of Personnel Management that I wish to comment on, as I feel there is a trade union point of view that needs expressing. In some

cases there is a form of paternalism whereby undue emphasis is laid upon the "welfare" side of Personnel Management and in some cases very lavish expenditure is incurred on social activities and amenities designed to encourage the "happy family" spirit amongst the employees; this defeats its own ends when there is conflict between management and the unions over labour relations questions, and particularly if, as on occasions during wage negotiations, the employer has referred to the cost of "welfare" as an argument against conceding a wage increase; the reaction of the employee in such cases is understandable, for they say if these things are included in labour costs they would prefer the cash value paid as wages. Paradoxically, difficulties can arise in an undertaking where the Personnel Department appears to be efficiently run mainly because the position of foremen, supervisors and technicians have not been fully considered in the scheme of things.

Any managerial grade supervising labour must be in a position and competent to deal adequately with labour relations problems arising in the unit or group for which he is responsible. I sometimes feel that the status of the foreman and supervisor has been impaired by an over-specialisation in some aspects of Personnel Management. This tendency is to be regretted as there is no substitute in industry for good foremanship. They are the representatives of management most closely in touch with the employees and good Personnel Management aids and assists the foreman and supervisor by training and assisting him in the handling of labour problems. The difficulty appears to arise from the desire on the part of management to relieve foremen and supervisors of some of their human problems in order that more time can be devoted to production problems. The probable effect in such cases is the lowering of morale in the group or unit, due to the feeling of the men that the foreman is more production-conscious than he is interested in their human problems and general well-being. The insistent and rigid attention to supervision on productive processes and insufficient attention to the employees' human problems by foremen and supervisors will lead to hostility and resentment, which may express itself in absenteeism and the increase in grievances on the job. Good performance within the group depends upon good supervision and the foreman who has his area of responsibility restricted by the exclusion of many of these human problems is not able to establish confidence and willing co-operation with the men he is associated with. Good Personnel Management dealing with a wide range of human problems should function in such a way that will assist and supplement other managerial grades in the performance of their duties. It does not mean that less attention need be given to the training of foremen, supervisors and technicians in the handling of human relations.

The Need for Co-operation

If we review progress in improved labour relations at all levels, national, regional and factory, during the past 25 years, we are encouraged by the definite improvements that have been made. A comparison of the working days lost through industrial disputes in the ten years following World War 1 and the ten years following World War II gives a striking illustration of this point. We appreciate the different economic circumstances in which we live today; we have exercised restraint in our demands; we place great value on full employment; and we know that by efficient industry and greater productivity we can maintain and improve our living standards and protect the social services developed in post war years. The Trade Union Movement, in accepting their responsibilities on behalf of the people they represent, have effected great changes and are consulted by Government and employers as never before.

A basis for co-operation has to be found at all levels and where there is a common interest this is possible by consultation whether it be formal or informal, and where we differ let there be mutual respect for each other's point of view. It is only by these methods that we can create the right atmosphere at all levels necessary for the establishment of good human relations. The building of good employer and employee relations is not acomplished overnight. It is the result of a considered and consistent policy on the part of management to deal fairly and justly with employees, for the ultimate response of the employees will be conditioned by what they have learnt to expect.

RESEARCH PUBLICATIONS

A number of copies of the following Research publications are still available to members, at the prices stated:

Machine Tool Research and Management	10/6
Report on Surface Finish, by Dr. G. Schlesinger	15/6
Practical Drilling Tests	21/-

These publications may be obtained from the Production Engineering Research Association, "Staveley Lodge", Melton Mowbray, Leics.

JOURNAL BINDERS

Strongly-made binders for the Institution Journal, each holding 12 issues, may be obtained from Head Office, 10 Chesterfield Street, London, W.1, price 10/6 each, including postage.

AUTOMATION—
SOME PROBLEMS CONCERNING THE EDUCATION AND TRAINING OF ENGINEERS

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Presented to the Oxford Section of the Institution, 13th December, 1955.

Mr. Parsons

Principal Parsons served his apprenticeship with Hudson & Co. (Engineers). After a period as improver with E. T. Pearson & Co. Ltd., he joined Vickers-Armstrongs Ltd., as a draughtsman in the Ordnance D. O.

He then joined the Hackbridge Cable Co. Ltd., and its associated company Bryce Ltd., where he ultimately became Chief Jig and Tool Draughtsman, engaged on the production of fuel injection equipment for oil engines.

Ten years were spent with the Lockheed Hydraulic Brake Co. Ltd., as Senior Tool Designer, Planning Engineer and during the Second World War he was responsible for the department manufacturing high pressure hydraulic pumps and similar equipment for the aircraft industry.

In 1946 he entered the teaching profession and after a short period as Lecturer in Production Engineering at Southend Municipal College he was appointed Principal Senior Lecturer in charge of Production Engineering at the College of Technology, Birmingham. In 1953 he took up his present appointment as Principal of Wellingborough Technical College.

Principal Parsons, who graduated as an external student of the University of London, is the author of "Production Tooling Equipment", published in 1954. A new book "Metrology and Gauging" is about to be published.

He is a past chairman of the Membership Committee of the Institution.

THE impact of automation on the work of the technical colleges and universities respectively was dealt with at the Margate Conference [1] by Principal Old [2], of Wolverhampton, and Dr. Matthew [3], of Birmingham. Principal Old discussed national policy, population trends, and trends in the output of trained men, and finally, the contribution of the technical colleges, with particular reference to future developments. Dr. Matthew, on the other hand, concentrated on the relationship between the university and industry, and discussed recent developments in university education to meet industrial needs. Both of these Papers, now published by the Institution, make a valuable contribution to the literature dealing with the education and training of engineers.

The primary purpose of this Paper is to focus attention on some of the problems with which we are confronted in the field of technical education, with reference to future requirements. There are no easy answers to some of these problems, but it is hoped to stimulate discussion concerning the educational framework, and the practical training necessary to enable engineers to make the fullest use of modern developments in science and technology.

Automation

Automation, as Sir Alfred Herbert [4a] has pointed out, will come gradually, and will apply only to a limited, but very important field of industry. The Chairman and Managing Director of Tube Investments Limited, discussing automation, has recently

stated that in the United Kingdom " . . . automatic methods are likely to be applied more widely to particular processes and assembly lines than to entire factories, and the pace of progress, therefore, is bound to be uneven " [4b]. However, automation cannot be divorced from other aspects of scientific and technological development. The utilisation of nuclear power, the vast new field of electronics, the modern development of aeronautics, including jet engines, of gas turbines and guided missiles, to mention the leading factors, all compete for adequately trained personnel. This immediately suggests a national problem — the question of supply — a problem which appears to be getting completely out of hand. There are also other projects, less spectacular perhaps, but of equal importance — plans for modernising the railways, and for the construction of new trunk roads. None of these plans can be carried out efficiently, let alone completed, unless the human material necessary to formulate plans, to administer and to carry out the work in all its aspects, is available.

It is well known that there is a desperate shortage of trained personnel, and that the relatively limited development of the atomic energy programme is due very largely to the shortage of trained scientific and technical staff. There is also an alarming shortage of science teachers in the schools, and a far from negligible shortage of qualified lecturers in the technical colleges. In addition, the universities are finding difficulties in filling some of their vacant posts.

The extension of automation will be possible only if adequate facilities are available for research, the resultant development work, and finally practical design. Technical planning, on the scale envisaged, makes teamwork a necessity. It means the formation of carefully integrated groups of specialists, each group working with a common purpose on a specific project.

Automation, with its fantastic possibilities, will, it is anticipated, reduce the demand for unskilled and even semi-skilled labour. There is no doubt, however, that it will increase the demand, very considerably, for skilled personnel, able to design, construct and maintain the plant and equipment required for its performance.

It has been suggested that automation, which in any case is a very costly business, cannot succeed, unless managements recognise that education generally must be revised (one writer has said " revolutionised ") to deal adequately with the impact of the problems involved. Addressing the Education Section at the British Association meeting in 1955, Sir Ben Lockspeiser [5] is reported as saying: " The fruits of fully automatic production engineering will be gathered only by a population substantially upgraded in skill and intellect, . . . "

I need not labour the point. There are now, and there will be increasing opportunities for work, not only of absorbing interest but of the greatest national importance, for scientists, technologists, engineers — call them what you will — provided they have been adequately trained.

Liberal Studies and Leisure

Another problem which is exercising the minds of many educationalists and others at the present time, is that dealing with the need of engineers, and other technologists, for wider liberal studies. A. N. Whitehead [6] has written: " A merely well-informed man is the most useless bore on God's earth. What we should aim at producing are men who possess both a culture and expert knowledge in some special direction. Their expert knowledge will give them the ground to start from, and their culture will lead them as deep as philosophy and as high as art. We have to remember that the valuable *intellectual* development is self development, and that it mostly takes place between the ages of sixteen and thirty."

I feel sure that we should agree that it is essential to avoid any sort of education which results in engineers having one-track minds. The need, surely, is for men able to make correct judgments ; to know, or at least be able to appreciate, the practical limitations of equipment, techniques and procedures ; having the ability to analyse a situation or problem ; and, in addition, having the capacity to enjoy, and able to make a personal contribution to the full life.

A leading article in *Nature* [7], published in July this year, discussing the " Social Implications of Automatic Control in Industry ", contains the following statement: " Automation . . . raises the question of education for an era of technological change in the broadest possible context, from that of general education to that of the highly specialised scientist or technologist, from the school to the university or institute of technology, and from the manager to the operator. Nor should the implications in respect of leisure and its use be overlooked." . . . "increased productivity is likely to be accompanied by an increase in leisure, and this can only be detrimental to a community that is unprepared or unable to make profitable use of that leisure."

I am sorry that it is not possible now to pursue the theme of this particular problem, notwithstanding its importance, even at the present time. I will, however, quote a warning given by Mr. Harry Rée [8] at the Bristol meeting of the British Association in 1955, when he said: " To an ever increasing extent we have handed over the organisation of our spare time to those who can make money out of us, to the purveyors of entertainment, to those who can offer us diversion without exertion, and hour after hour we are content to watch, to listen and to consume."

Technical Education

You will appreciate, from what I have said, that the subject of ' technical education for the future ' has been discussed widely. You will have noticed also, if you have had an opportunity to delve into these matters, that little guidance is given as to how the necessary upgrading and general transformation of the educational scene is to be realised. This is not unexpected, since it is a very complex national problem, the solution of which can be achieved only after prolonged discussion, bearing in mind the issues involved.

There are many critics of the results of present day training methods. It is said, for instance, that young men lack the power to apply that training to practical

problems found in industry. A leading article in *The Times* [9] recently stated: "By the side of a comfortable if not equally convincing assurance that Britain is unsurpassed in producing pure scientists of the greatest *distinction*, there has been a recognition that in the application of science to industrial development there has been a conspicuous and disturbing lag."

One of industry's requirements then, is for more men who can see the practical significance of scientific discoveries, and this must be considered an important national problem. Engineering is an applied science, and as engineers, we should give our full attention to this matter.

In accordance with present day nomenclature, I am going to consider the educational requirements firstly, of the craftsman, secondly, of the technician, and finally, of the professional engineer or technologist. In the past it has been recognised that many paths led to the top. No doubt in the future, as in the past, the best men will find their way to the highest posts available. But it is becoming evident that for those who do not "start right", it is going to become increasingly difficult to make the top grade.

One of the urgent problems that should be faced is to decide the proper relationship between general education in the schools and the needs of the apprenticeship system. Some adjustment will certainly have to be made. I agree with the proposal that the longer the period of schooling, the less should be the period of apprenticeship. Schooling should provide a young person with those special needs which will permit him to develop both physically and intellectually to his full capacity. The breadth of his general education will determine, not only his ability to deal with the mental disciplines necessary for his future career, but his power to understand and absorb them far more quickly. He needs to be able to communicate ideas to others, and equally to be able to understand other people's ideas. Mathematics, properly taught, should influence his reasoning powers and prepare him for the processes of logical thought and judgment.

Skilled Craftsmen

I should now like to consider some of the problems associated with the education and training of skilled craftsmen with special reference to the apprenticeship system. I was interested to read the presidential address given to the psychology section of the British Association in September last, by Mr. Alec Rodger [10], Reader in Psychology at Birkbeck College. He suggested that a thorough examination of the apprenticeship system and all the good and bad restrictive practices associated with it was needed. The fact had to be faced that many apprentices were not being trained in a profitable way; that those young men often wasted their time on jobs no one would dare mention in a printed syllabus; that they were often kept on particular jobs far too long, because production was given priority over training; and that they often stood no chance of gaining the breadth of experience the potential journeyman should have. It was true that in some industries all these matters were receiving attention. Requirements were being modified; training was becoming more systematic; and exceptions to rules were being made. But it must not be imagined that progressive-looking agreements reached at the national level were always acted upon at the local level, because they were not.

I know that we are members of a professional institution. Nevertheless, you will probably agree with me that the Institution has some responsibility for the education and training of skilled craftsmen. I am forced to the conclusion that we have neglected this opportunity, since it was, I believe, as long ago as 1935 that detailed attention was given to the subject. Present and future requirements demand that the whole educational system be reconsidered. It follows that the education and training of craftsmen is of equal importance with that for any other group of personnel.

In his Paper "The Training of Craftsmen", presented to the Institution of Mechanical Engineers in 1951, Mr. J. Loxham [11] suggests that the evidence shows that, in spite of the cost of education, the engineering industry in this country is not being supplied with the number of highly skilled craftsmen that is needed. The reasons he gives include the suggestion that there is insufficient difference between the earnings of skilled and semi-skilled workers, destroying the incentive to the young entrant into industry to study and to train for a skilled job. Another reason given is the transfer of all forms of production planning from the factory floor to the works office. Mr. Loxham believes that employers' associations set too low a standard as the minimum standard of training to be given to trade apprentices. He condemns the restrictive practices of trade unions designed to prevent one man doing the work embracing the skills of two trades. Mr. Loxham suggests that the beliefs that when a person by the use of his hands and certain mechanical aids produces a required result, he is not using his brain, and that all office work demands more intelligence and more mental concentration than factory work, are *erroneous*.

I suggest that so far as future requirements are concerned we have to make quite certain that craft apprentices appreciate the importance of their work, and of their status in the industrial community. In addition, I feel that it will be necessary for the apprentice, aiming at becoming a skilled craftsman, to increase the breadth of his theoretical studies. This will mean additional time spent either in the works school, or in the technical college. It applies particularly in the latter stages of training, when the apprentice more readily absorbs knowledge and benefits from experimental work in the laboratory. Evenings should be free for homework, recreational and social activities. Students under eighteen years of age should not be expected to attend evening classes concerned with their vocational training. Compulsory evening attendance, unless unavoidable owing to some emergency factor, should be eliminated.

The disadvantages of evening classes, or evening courses of study for serious work, for young people are well known and appreciated by many employers. On

the other hand, some employers require young students to "show willing", by attending classes on one or more evenings, in addition to their day attendance. There is no objection to craft students attending leisure studies, or classes not compulsory to their day course, in the evening.

With regard to practical training I would emphasise the point I made previously, namely, that length of time should vary according to the time spent at school. In addition, consideration should be given also to the potential apprentice's attainments at school. Youths aiming to becoming highly skilled toolmakers and maintenance technicians will probably continue to serve a maximum five years apprenticeship. The academic qualifications of the craft apprentice will continue to be those devised by or associated with, the City and Guilds of London Institute.

Some Definitions

Let me now turn to the middle and higher grades of engineers. First, it may be pertinent to give some definitions. The *Oxford Dictionary* defines a technologist as "one who studies practical or industrial arts scientifically". The engineering technician has been defined as "one who can apply in a responsible manner proven techniques which are commonly understood by those who are expert in a branch of engineering or those techniques specially prescribed by professional engineers". The term "professional engineer" is fashionable at the present time, and has been defined as "one who is competent, by virtue of his fundamental education and training, to apply the scientific method and outlook to the analysis and solution of engineering problems. He is able to assume personal responsibility for the development and application of engineering science and knowledge, notably in research, designing, construction, manufacturing, superintending, managing and in the education of the engineer. His work is predominantly intellectual and varied, and not of a routine mental or physical character. It requires the exercise of original thought and judgment and the ability to supervise the technical and administrative work of others."

You may feel, as I do, that the division of engineers into two complementary grades is a simplification. It may be difficult to see the exact stage where one converges to the other. This, however, is relatively unimportant. The essential factor surely, is the necessity for the path to be sufficiently wide for the man with the necessary intellectual capacity and personal ability to be able to reach the highest positions that industry and his profession have to offer.

Engineering Technicians

Let us now consider the education and training of the engineering technician. His duties, it has been suggested, include design, development, and erection of engineering plant and equipment; drawing, estimating, inspection and testing; operating, maintaining and repairing such plant and equipment, and other activities connected with research, development, etc. His education and training, therefore, must be such as to enable him to appreciate the nature and purpose of his work. It is the technician who will be in closest touch with skilled craftsmen, because one of his responsibilities may be their direct supervision.

Dealing first with the theoretical studies of the technician grade, I suggest that these will continue to be obtained primarily through part-time day release courses of study. I am sure that there will be general agreement when I say that National Certificate courses have been highly successful in the past. It has long been felt, however, that the present National Certificate courses are too narrow. The reason for this is because, up to the present time, numbers of candidates seeking professional status have qualified through Ordinary and Higher National Certificate courses, followed by appropriate endorsement subjects. The minimum qualification for an engineering technician now is the Ordinary National Certificate, either in Electrical or Mechanical Engineering, or Mechanical Enginering with a production bias. This minimum will have to be raised, and there is little doubt that the technician of the future will require qualifications at least equivalent to the present standard of the Higher National Certificate. "It is at this level" according to a leading article in a recent issue of *The Times Educational Supplement* [12] ". . . the level of the Higher National Certificate . . . that our manpower lags most seriously behind that of the United States."

Young men training to become engineering technicians should have preferably received either a secondary technical, or a grammar school education, up to the age of sixteen at least. But, at the same time, many boys from secondary modern schools should be capable of achieving technician's status. Such boys would, however, benefit from a full-time preliminary year at a college of further education, before proceeding to the normal part-time day release courses as apprentices.

The Minister of Education [13] has himself suggested that secondary modern schools must regard themselves as the major source of supply of students for the technical colleges. The Government's view suggests that the main purpose of the technical college is to provide education of a vocational character, through both full-time and part-time courses, as may be necessary, which do not conflict with either the schools or the universities.

In his address to the Association of Technical Institutions in 1952, Sir Norman Kipping [14] maintained that the training of the middle ranks of industry was the main task of the technical colleges. He would not wish, he said, to deny the colleges opportunities for advanced work but their chief place was, and should be, with the intermediate levels. Some would quarrel with this statement, but it is well to remember that quite an appreciable amount of higher work is, in fact, undertaken in the larger technical colleges. Furthermore, it would lead to even greater difficulties if it were curtailed in any way.

I should like to say a few words about the secondary technical schools, with special reference to their participation in the education of technicians.

This relatively new type of school, and I am not forgetting the good work of the former Junior Technical Schools, should provide an increasing number of boys with a good basic education, coupled with a vocational background suitable for those who wish to make careers as engineering technicians. *The Times Educational Supplement*[15] in a special article, suggests that "... the technical schools can do much more than duplicate what the grammar schools are already doing. They can provide an atmosphere of quite a different kind, which will give pupils both a pride in their vocation as valued servants of industry and the work they do a practical bias." Unfortunately, the number of secondary technical schools is small, probably about one-fifth of the total number of grammar schools. It is to be hoped very much that their number will increase.

Another avenue for the education of technicians is the university. It should not be forgotten that many men who leave the university have not reached the honours level. Mr. K. G. Denbigh[16] has pointed out in *The Times Educational Supplement* that "... it is frustrating to the young student and needlessly expensive to the community to force him to the honours level if he does not have the necessary academic talents. There are an increasing number of posts in industry which require a fair knowledge of science or engineering, but not an advanced knowledge. For such work it is once again frustrating and wasteful to seek to employ the honours man."

With regard to the advanced work necessary for technicians, I suggest that there will be less frustration if this is of a specialised nature, especially for those who do not need to study mathematics to an advanced level. Draughtsmen, for instance, after completing the Ordinary National Certificate, might undertake a course specially prepared for their particular interests, as distinct from professional engineers qualifying as designers.

So far as practical training is concerned, the engineering technician does not require the same emphasis on manual training compared with the requirements of the craft apprentice. I would suggest that not more than three years be spent in the shops. A further two years should be related to the particular function with which the individual will ultimately be concerned, in the drawing office, planning department, etc.

Attendance at the technical college, normally on a part-time basis, should be for not less than one and a half, and preferably for two days a week, but not more, throughout the major part of the course. Evening work should be non-vocational in content. My remarks concerning evening classes apply with equal force to the technician, so that it is unnecessary for me to repeat what I said previously. Before leaving the subject of the technician I would suggest that the overall length of time spent on further education and training should depend on the time spent at school, coupled, of course, with the subjects studied. It is the technician's group that requires upgrading. Theoretical studies should be more evenly balanced with practical training, and the latter should consist of something more than the manual training suited for the craft apprentice, such as process planning, tool design, materials handling and case study work.

Professional Engineers

It is now time for the professional engineer (or the technologist, as he may be called) to receive attention. The subject of higher technological education has been discussed to such an extent during the past few years, that it may appear presumptuous on my part to attempt to add to the mass of opinion that is available in newspaper files, in the proceedings of learned bodies, in educational journals and in numerous government publications. It has been the subject of bitter debate and of protracted argument.

There is little doubt that future requirements will make it essential for professional engineers to have not only a greater breadth, but also a greater depth of theoretical knowledge. The normal way for the professional engineer to qualify in the future will, I suggest, be through a full-time course, either at a university, or through a sandwich course at a regional college of technology. This viewpoint is confirmed in a special article published in *The Times*[17], where it is stated: "Part-time 'day release', usually limited to one day a week during a five years apprenticeship, is not enough to ensure the breadth and depth required of a professional technologist, especially one who during the next 40 years or so will have to cope with industrial and social conditions changing at a rate never known before in the world's history."

In addition to the facilities for higher technological education provided by the universities and the technical colleges, there is a small number of national colleges financed directly by the Ministry of Education. The two bodies ultimately responsible for technical education as a whole, in this country, are the University Grants Committee and the Ministry of Education, in association with local education authorities. I do not wish to spend time discussing past difficulties, because I believe that the situation has improved of late. The most important development in recent months has been the Minister of Education's statement regarding the formation of a new council to be responsible for Diplomas in Technology, which I will discuss shortly. Meanwhile, I feel that this factor has, to some extent at least, more clearly defined the division between the universities and the major technical colleges to the advantage of both.

The University Grants Committee published, in 1950, "A Note on Technology in Universities." This document states[18]: "We believe ... that the aspects of technology appropriate to universities and technical colleges are not the same, though they may overlap to some extent. The difference between the two types of institution is not in status or grade, but in kind. But it would, we think, be generally agreed that the work of a university in technology should be more closely related to fundamental science or other relevant studies than that of a technical college. In general, the courses should be more widely based on higher standards of fundamental science, and con-

tain a smaller element of training related to immediate or special work in industry."

I will now return to the new National Council which I mentioned previously. In July of this year, it was announced in the House of Commons, by Sir David Eccles, Minister of Education, that Lord Hives, chairman and managing director of Rolls-Royce, Ltd., had been appointed chairman of a new body to be known as the National Council of Diplomas in Technology in Technical Colleges. Some people feel that this statement has paved the way for an established policy for higher technological education. The least it has done is to show more clearly the pattern of the future, in which technical and technological education will be available, namely, in universities, in selected regional colleges of technology, and in local technical colleges. The new diplomas, which are to be "comparable in standard to a university first degree", will, of course, have to prove themselves, and be found acceptable by industry.

In reporting this new award *The Times Educational Supplement* [19] stated: "It is good on many counts that technical colleges should have been given a permanent share in the production of technologists of the higher sort — and not only because it means another ladder for climbing. Technical colleges have a different approach — they are a degree nearer the workshop floor than universities."

The new national council will be an independent self-governing body, operating under a deed of trust. It will consist of five persons appointed by the Minister and three appointed from their members by each of two boards of studies. The board concerned with engineering will consist of 28 members, of whom five will be nominated by the Minister and the remaining 23 by professional and other associations. The board of studies concerned with technologies other than engineering will have 26 members, of whom five will be nominated by the Minister. Professional and other bodies will nominate the remainder. The boards will be responsible to the council for the curricula and syllabuses of courses prepared for the awards. In particular, they will be responsible for the standard of the college work in pure science and in technologies related to the courses, as well as for the standard of admission and of the final examinations. They will be responsible for the qualifications of the teachers, for the buildings, and the equipment, and for the conduct of the examinations. It is not intended that the council should be an examining body, but one that will ensure that the general conditions are satisfactory for candidates seeking the award.

Earlier in this Paper I suggested that one method by which a professional engineer might qualify academically would be through a sandwich course at a regional college of technology. "Sandwich" courses are those in which periods of full-time attendance at a technical institution alternate with periods of full-time training in industry. Such courses are far from new and the first development of this kind took place at Sunderland Technical College[20] at least 50 years ago. Fresh interest has been aroused in the provision of sandwich courses in recent years. They involve close co-operation between industry, or the company concerned, and the technical college. If you are not familiar with the scheme, I would draw your attention to the industry-based sandwich course initiated by the General Electric Company, Ltd., in association with the Birmingham College of Technology[21], which is of special interest.

This course is intended for youths of 18 years of age from public and grammar schools, whose education has been on a broad basis, and who have gained the G.C.E. in five subjects, including English, mathematics and physics, at the Ordinary level, and preferably with one at the Advanced level. The scheme offers a number of advantages to the potential professional electrical engineer, including the personal association with a leading company interested in the manufacture of a wide range of products, and being associated with a well-known established technical college, having an excellent reputation for educating engineers of all kinds. The student is paid on an increasing scale, and the company pays the college fees in full.

It is reported that 60 students commenced at the College under the scheme this year, and it is anticipated that within three years the number will have risen to between 300 and 350. Students spend four sessions at the college, and each student is expected to select at least one field of study outside his technological studies, such as economics and human relations, law, languages, history and philosophy.

It will be felt that small firms cannot hope to provide and support such schemes. However, it has been suggested that it may become the self-appointed task of the larger companies to be responsible for apprenticeship and training schemes within the industry. On the other hand, apprenticeship and training schemes provided by relatively small firms may offer definite advantages, especially from the point of view of personal relationships.

Post-Graduate Studies

For students capable of profiting from higher work, above first degree or diploma level, provision must be made for post-graduate studies and training, of such a character that they receive adequate support from industry. In other words, industry will not only welcome men who have taken such courses, but will be actively supporting these schemes by releasing men to attend them. In some technologies, and certainly for scientific workers, many such courses are available, but the position regarding production engineers in this particualr respect is far from satisfactory.

In the 1954 Sir Alfred Herbert Paper, "Some Problems of Higher Technological Education", presented by Lord Halsbury[22], at the Production Conference held in that year, an analysis is given of the possible reasons why so few graduates receive specialist training in production engineering at the conclusion of their university or technical college course. Lord Halsbury's comments on this situation are pertinent. He states: "I can attribute it myself to the invincible reluctance of the present day employer towards paying a specialist enough to make it

worth his while to specialise, and I take it as symptomatic of the fact that even at this late hour the employer is unconvinced of the value of the academic approach to technical education." That comment, surely, sums up a problem of some magnitude.

A significant development in the field of higher technological education is that concerned with the Imperial College of Science and Technology, under the Government expansion scheme. Dr. R. P. Linstead[23], the new Rector, in his inaugural address, delivered in October last, emphasised the importance of post graduate courses. He declared that of the 3,000 students it is anticipated will attend the college by 1962, about 45 per cent. will be post graduates.

Teaching Staff

The success that results from any educational enterprise varies to a considerable extent, according to the calibre of the teaching staff. Many men, it is suggested, who would make good teachers, are detracted from teaching because of the relatively poor financial rewards, especially at the higher levels. But the importance of securing the best type of teacher cannot be over-emphasised, and the best type of teacher engaged in technical education is one who has himself successfully borne responsibilities in the industrial field. The answer to this problem may well be that a far greater number of practising engineers and executives should provide their services as part-time lecturers, particularly in the regional colleges of technology. Not only would the colleges gain ; so also would industry. The gap between the colleges and industry would tend to close. The criticisms of college staffs, that industrialists lack interest in technical college students ; that they give inadequate support to college courses and leave the colleges very much to themselves, would then scarcely be justified. On the other hand, the criticisms of the industrialist, that technical college teachers tend to be too academic, and that they lose contact with industry, also could be overcome, if more teachers took advantage of the arrangements which permit them to return to industry for varying periods up to six months without loss of pension rights.

Not only are efficient teaching staffs necessary, but adequate facilities for teaching the new techniques are essential, if the colleges of technology are to play a leading part in the coming years. It may, however, be more economical for students to receive instruction in the works, under actual operating conditions, than for pilot plants, or similar projects, to be provided in the colleges.

Management Training

Although the aim of this Paper has been to consider the education and training of engineers, it must be remembered that relatively large numbers of qualified engineers ultimately become administrators. I have read that one of the difficulties of employers is to find men, with specialist qualifications, who are capable of undertaking responsibilities in a broader field, particularly in that of administration.

Management studies have developed in a variety of ways — in technical colleges both full-time short residential courses and part-time courses, in special colleges such as the Administrative Staff College, in universities to a limited extent, through summer schools, and in other ways.

Should all engineering students be expected to study management subjects? Would it not be more effective generally, and less frustrating for the individual, if students were sponsored by their firms? It is generally accepted that it is impossible to teach a man to be a manager. Academic attainment is only one facet. A man must have certain personal qualities in addition, to become an efficient manager. Therefore, it would seem to be reasonable if men were selected for management training because, in the view of their superiors, they possessed certain necessary characteristics, which would enable them to benefit from such a course.

I am not suggesting that it is in any way a bad thing for a young engineer to have some knowledge of industrial administration, rather the reverse. What I wish to emphasise is that time should not be spent on management studies on men who, either by inclination or by lack of the necessary qualities, could spend that time more advantageously in other directions. There is, I believe, a considerable body of opinion behind the recommendation that colleges should give far more attention to the preliminary standards of admission to management courses.

The engineer turned administrator is capable of appreciating scientific and technological change, and to assess these changes with reference to his own company's requirements. It is of equal importance that he should be capable of appreciating new management techniques and their practical application. In recent years the emphasis has been on such techniques as budgetary control and standard costs, quality and statistical control, work study, incentive schemes and profit sharing.

The ultimate aim of management education and training is to stimulate ideas, based on the working of a group of people directed towards some specific end. Case studies are unique in this respect, and although they cannot be, or rather, should not be used in isolation, they are of the utmost value, as a teaching method.

Members interested in management training are recommended to read the publication "Training and Education for Management in the Iron and Steel Industry", published this year by the British Iron and Steel Federation. It contains much of value.

Professional Production Engineers

In conclusion, I should like to spend a short time discussing the special problems relating to professional production engineers. Automation will, of course, present the production engineer with a new challenge. It will increase, also, his responsibilities and make it necessary for him to be able to consider production requirements from a new angle. One of the interesting developments will be in the changing pattern of higher technological education. Since the time of the Industrial Revolution the emphasis has been on

training engineers for design and research. It was only in 1941 that the Higher National Certificate in Production Engineering was instituted. Even now the number of Production Certificates, compared with those awarded to young engineers trained according to tradition, remains very low.

But I believe that there will be a subtle change, and the seeds sown by this Institution ultimately will bear much fruit. Education for manufacture will become of the greatest importance, and the design of the product will, I suggest, become more and more within the province of the production engineer. I do not mean, of course, that the production engineer will take over the responsibilities of the designer. I suggest that the relationship between the design of the product and its method of manufacture will become so intimate that the production engineer will have to bear the increasing responsibility of approving the design as being suitable for the particular manufacturing plant for which he is responsible. The production engineer's interest in the product commences from the inception of the design, and will continue until the product is ready for delivery to the customer.

The professional engineer will have to be a specialist, but something more will be required. As I mentioned at the beginning, the process of manufacture will continue more and more to be the result of teamwork. It is this aspect which makes it necessary for the specialist to be able to appreciate the work of the other members of his team. The emphasis in the future will be on the design, control and maintenance of integrated production units — the automatic factory. The production engineer, therefore, will hold a key position, and his main task will be the efficient utilisation of manufacturing plant and equipment designed for very large outputs. This means that he should possess a sound knowledge of the principles underlying his technology. He should possess also a knowledge of the basic sciences, physics, chemistry, etc., and of mathematics and statistics.

The production engineer should be familiar with the techniques of other specialists, e.g., electronics, servo-mechanisms, the design of transfer machinery, and so on. Especially should he be aware of the modern techniques used by management for measuring efficiency and for assessing requirements, some of which I mentioned when discussing management training. In addition, the professional production engineer must be capable of communicating ideas to others in a logical manner. He must receive and understand the ideas of others, and not only from engineers. The ability to use at least one foreign language also is desirable. This will permit him to keep in touch with technological developments abroad, and also to conduct business abroad more efficiently.

With regard to practical training, manual skill should not be necessary. This training should be gained in the various departments comprising the organisation, such that the prospective production engineer learns to appreciate production processes, techniques and the principles of organisation. This form of training should inculcate the vital need for team work.

Finally, the aim of this Paper has been to spotlight some of the problems, both current and future, in the educational field. I hope that I have said enough to stimulate some discussion on the subject.

This Institution has accepted the challenge of the New Age, and the tasks which lie ahead. The opportunity for service to the community has never been greater. Although the way may be hard, to the young production engineer especially, the future offers unlimited possibilities.

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UNIQUE METHODS USED IN THE MANUFACTURE OF TWIST DRILLS, TAPS AND DIES

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Presented to the Melbourne Section of the Institution, 13th April, 1955.

THIS Paper describes some of the manufacturing methods and processes used in the manufacture of twist drills, centre drills, screw extractors, taps, and finally, dies.

TWIST DRILLS

Our first item is the manufacture of twist drills which are defined as end cutting tools having one or more cutting edges and having helical or straight flutes or grooves adjacent thereto for the passage of cuttings or chips, and used for originating or enlarging holes.

A drill of some sort has been used throughout the ages and it is said that samples are in existence from the Stone Age. The advance from stone to metal must have been to early peoples as great an advancement as the change from carbon to high speed steels and then to carbides in our own industries. The pace of modern life, with its jets and rockets, is forcing the drill makers to keep abreast of developments.

The twist drill was developed during the 19th century after the flat or spade drill reached the limit of usefulness and as late as 1919, in the fifth edition of "Machinery" Handbook, it is recorded that "straight shank drills $\frac{3}{8}$" in diameter and less are usually not ground after heat treatment".

Materials and Design

With the exception of specials and drills of large diameters, all taper shank drills are made from two separate steels; the body or pod portion from high speed or a cutting steel to do the work, while the shank, used only for driving, is invariably made from a medium carbon steel (0.4 - 0.5% carbon) to allow the tang to be toughened to prevent burring over when being removed from socket or spindle by means of a drift. The shanks on smaller drills up to 21/64" are knurled after fluting; heat treatment follows, and they are then pressed into a prepared shank, the centreless grinding operations taking place afterwards to ensure concentricity.

The larger taper shank drills are made from shank and body material flash butt welded together. Only when it suits us do we weld size to size metal, as machining costs are reduced by welding a shank with a $\frac{1}{16}$" allowance for machining to the high speed end stepped down to shank metal diameter. A taper shank is then generally reduced to within 0.012" for grinding allowance by one cut for a No. 1 or 2 morse taper shank, one or two cuts for a No. 3 morse taper and two cuts for a No. 4 morse taper shank. The largest we regularly weld is for $2\frac{1}{2}$" diameter drills.

Easily the most popular drill is the two-fluted type, and the lead of helix for these flutes is generally constant for the whole length, although some are made with a gradually increased lead from the point to the shank. However we do not know of any virtue claimed because of this design. The standard drill has a lead of helix approximately $6\frac{1}{2}$ to 7 times the drill diameter and can be measured on the outside diameter from a point on the land to a similar position when the flute completes one turn (Fig. 1). The helix angle is taken from along the line of spiral flute and the drill axis. Except for specials, the web or core thickness between the flutes increases from the point of the drill to the shank and varies with different manufacturers from 0.010" to 0.020" per inch. This taper core is necessary even for normal work and essential for high speeds and feeds. The web thickness is approximately one-sixth of the diameter for very small drills and one-eighth for the larger sizes, this being a rough guide only.

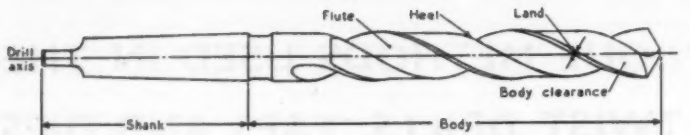

Fig. 1.

Steels

There are two types of high speed steel in general use for drill manufacture ; the 18 : 4 : 1 (0.75% carbon, 18% tungsten, 4% chromium, 1% vanadium) and a tungsten-molybdenum type also known as a 5 : 6 : 2 (0.85% carbon, 5% molybdenum, 6% tungsten, 4% chromium, 2% vanadium). Since a good tool must be made from a good steel, no steel is issued until tested and approved by the laboratory and heat treatment departments. Specifications are supplied to the steel maker and every heat in a shipment is tested to ensure that the steel is within specification by taking samples from two bars at random and testing for composition, decarburisation and condition.

For composition, the elements checked in high speed steel are carbon, tungsten, molybdenum, chromium and vanadium. The carbon figure is very important when it is realised that many thousands of tools are being heat treated each day and the treatment must be of a standard nature, although there are some variations in hardening temperatures specially applicable to differences in composition.

Decarburisation testing is always carried out on the " as received " steel and the depth must be held within certain limits, so that when the turning allowance is removed the decarburisation is also removed. Our method for testing decarburisation is by giving a normal heat treatment as later described in detail, to a section cut off a bar about $\frac{1}{2}$" thick. This is ground in 0.005" steps until a hardness of 63 Rockwell " C " scale is reached for high speed steel, when we consider the decarburisation has been substantially removed. Decarburisation is the loss of carbon from the surface of steel as a result of heating in a medium (such as air) that reacts with carbon causing partial or total decarburisation. Either state is undesirable, since if any decarburisation remains on cutting edges they will be soft after heat treatment, and will wear rapidly.

Condition, the last main item checked, covers whether the steel is in the correctly annealed condition with freedom from segregation and also surface defects.

Butt Welding

Approved steel having been issued from the store, shank and body are parted off and stepped where required to suit any differences between diameters. A light sandblast before welding cleans and removes

Fig. 2. Flash butt welding with automatic upsetting, showing the ' sunken bed '.

any burrs. The welding blocks have been bored out to $1\frac{3}{4}$" diameter and there is a full range of suitable sleeves with an outside diameter to suit the block with bore diameters in 1/64" steps. The top half bearing is held up into position by two $\frac{1}{4}$" bolts ; the bottom half has a location pin only. Sleeves are split lengthways to give two half-bearings and it will be clear that by changing the sleeves to the required size, the parts to be welded are automatically central. The flash butt welding machines (Fig. 2) have a "sunken bed" so that the work in the blocks is in line with the thrust, thus allowing no uplift, and are designed to allow manual control of preheating and flashing, whilst upsetting is carried out automatically by the operation of a compressed air cylinder or manually as required. In flash butt welding the two pieces of stock to be welded form part of an electrical circuit which carries low voltage (3 - 5 volts) and high current characteristics.

The shank and pod are arranged adjacent to each other with their abutting surfaces in light contact or with a minute air gap between them ; a heavy current is allowed to pass through the circuit. This causes a flashing action between the pieces of metal, which is allowed to continue until the metal is in a semi-fused condition ; the weld is then completed by butting together. In making a flash weld with $1\frac{5}{16}$" diameter metal we would make a $\frac{1}{4}$" allowance in stock length for "burn off" and "push up". The "burn off" represents the loss during flashing whilst the "push up" represents the loss of strength during the upset. Welding times vary with sizes but a $1\frac{5}{16}$" diameter face takes approximately $1\frac{1}{4}$ minutes, floor to floor time.

The freshly welded blank, on being removed from the clamps, is very quickly pushed into a bin of mica dust, the weld being well covered to allow the heat to be retained for a maximum time. This prevents 'cold shorts', which are caused by the quenching effect of the cold metal and results in breakage within $\frac{1}{16}$" of the weld. The other most common welding fault is caused by allowing the movable platen or side to ease back after the upset stroke before the clamps are released; this tends to pull apart the fresh weld.

Next, the welded blanks are removed from the mica and transferred to an annealing furnace. The work is brought to 750°C. and held for five hours ; this is termed sub-critical annealing. Rumbling in a sand-blast machine removes any scale.

Machining

The 118° drill point is formed and the welding fin removed ; the average speed would be 376 - 400 r.p.m. for both operations, which are completed together in a capstan lathe. For pointing or coning, a tungsten carbide tipped tool is used, set at centre height with a 5° negative rake, machine feeding the tool into the end of the blank until the correct length is obtained, and using a roller box to keep work central.

The shock or interrupted cutting to remove the weld is best done with a Stellite tool which is wound straight into the work, this procedure being arrived at after exhaustive tests. The blank after being straightened and centre drilled in the shank is now ready for turning.

The 118° drill point is used in a female centre when turning and no difficulties are experienced, the shanks being turned first using a tipped tool with a 0.015" deep chip breaker, 1,440 r.p.m. and a 0.009" feed. As mentioned previously, this produces a No. 1, No. 2 and sometimes a No. 3 morse taper in one cut using a good flow of soluble oil. A similar tool is used for turning the body running at 1,440 r.p.m. and a 0.006" feed rate, no trouble being experienced with the remains of the welding fin.

Flute Milling

For milling the flutes there is a specialised milling machine with table set at an angle to reduce or eliminate side interference when cutters are working, and suitable gears for whatever lead of helix is required.

For the most common right-hand spiral flute, the table is set from the right-hand side. Left-hand fluted drills differ in the set-up by the table being set at an angle from the left-hand side, and an intermediate gear added to give the change of direction with the flute. The arrangement of the machine (Fig. 3) is such that the table carrying the workpiece drops by a cam action as the blank is being fluted, thus giving the web thickening. For milling the flutes the cutters have two radii, this special shape being required so that the lips of the finished drill will form two parallel straight lines the thickness of the web part.

Where possible, the machines have been converted to down or climb milling which, of course, means that the cutter rotates in the same direction as the feed, and the diminishing cut per tooth obtained by this means gives a better flute finish than is possible from conventional milling. Surface condition usually starts to deteriorate within the first hour on conventional milling, but after climb milling the first and last blanks from an eight-hour production run had a surface finish with no detectable difference. We have to be guided by the cutter appearance for regrinding. To show what can be obtained from the change from conventional to climb milling, we ran a single flute milling machine on conventional cutting until the work showed the usual build up signs of end of cutter life. The driving belt was then crossed and by climb milling the cutter gave a first-class finish for six hours before cutter grinding was necessary.

In the drill section, the machine developments of interest are semi-automatics carrying five blanks held in suitable adaptors. On pressing a starting button, soluble oil runs, cutters start at 210 r.p.m. and the carriage runs forward at 70" per minute fluting at 4" per minute, rapid return, auto index, advance, flute return and stop, the whole cycle being $2\frac{1}{2}$ minutes to complete five drills. The operator looks after two machines thereby averaging four drills per minutes. These times apply to $\frac{3}{16}$" - $\frac{5}{16}$" but vary according to drill size.

Cutters (Fig. 4) are made from high speed steel $3\frac{3}{8}$" diameter, with 14 teeth. The full form is relieved

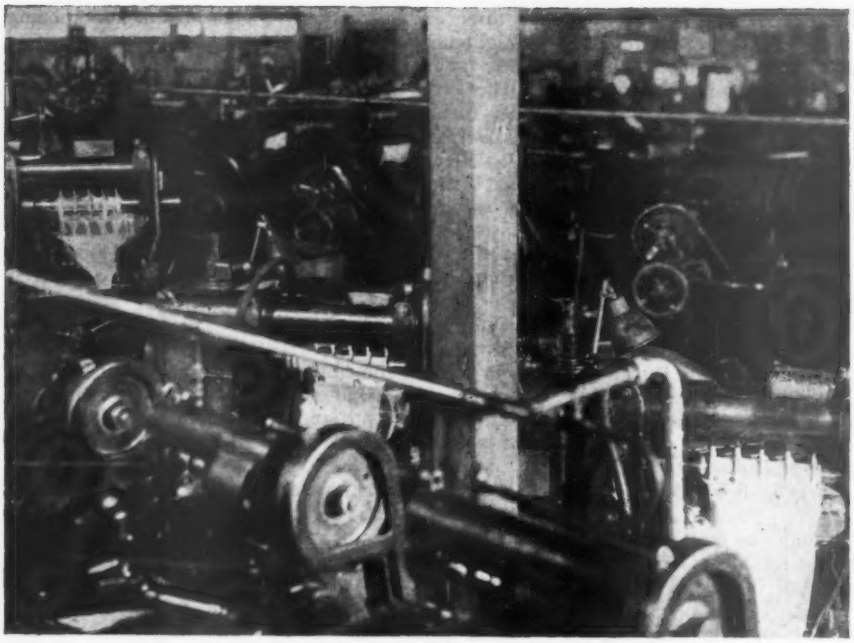

Fig 3. Flute milling.

Fig. 4. Cutter detail on multiple drill flute milling machine.

on the teeth and grinding is only necessary on the cutting faces ; but care is exercised to ensure that the five cutters are all the same diameter, thus controlling the web thickness of the drills being fluted at a constant setting.

Jobber or straight shank drills are parted off to length, with a 118° drill point each end. This greatly assists in determining the correct position for the fluting cutter, the point shape being very similar to the finished job ; likewise, the correct shape only needs relieving by grinding when finish pointing. These blanks are fluted in similar machines, the adaptors only being different from those which hold taper shanks.

Relieving and Tanging

Drills $\frac{1}{16}$" and over are now machine relieved ; all sizes under are relief ground later on, with the exception of 60 to 80 wire gauge, which are not relieved as a standard but are done regularly down to 73 wire gauge on request.

Relieving is the removal of metal leaving a narrow land or margin up to drill size and is necessary with the larger drills to prevent excessive friction between drill and walls of the drilled hole which would cause drill failure.

For taper shank drills tanging is the next operation. The drills are held two at a time in a jig and fed into two pairs of half round cutters correctly spaced to give the tang width, and the radius on the cutters gives strength to the tang.

Heat Treatment

The next move is to heat treatment and the importance of this section needs no emphasis. Continual checking and cross-checking of the instruments for recording hardening temperatures starts the day, and the first piece through the furnace is a short $\frac{3}{8}$" round section which is immediately broken for a grain size inspection. A further sample is hardened and tempered, then prepared for micro-examination as a more complete check on the hardening temperature. The workpieces are on their way by this time, but grain tests are taken every hour and further cross-checking of temperatures is carried out half-way or four hours through the day. With up to 40,000 pieces from 80 wire gauge (0.0135") up to 4" diameter being heat treated in a day, it is very important to make no mistakes in this department.

The drills are loaded into suitable jigs and conveyed at a predetermined time cycle through a drying chamber to remove moisture. Then through a preheated salt held at 850°C., followed by immersion in a high heat salt at approximately 1,230°C. to 1,240°C. for molybdenum steel, continuing with close adherence to time and temperature to a quench salt at 580°C., which also acts as a solvent for the high heat salt, and finally finish cooling to room temperature in air. Whilst in this section, it is of interest to note that the lower temperature furnaces are oil-fired and temperature is controlled by indicating controlling instruments through angle type thermocouples. We find mild steel sheaths for thermocouple protection in low heat salt baths are most suitable. Temperature control of the high heat bath for high speed steel hardening is controlled by a radiation type pyrometer connected to a recording controller.

The high heat furnace is electrically heated, the three electrodes being placed in the form of a triangle inside the walls of the pot. The salt acting as a conductor is heated and agitated by the flow of current from one electrode to another thus keeping the salt mixed and at a constant temperature throughout the entire pot. Most tools from high speed steels are given a triple tempering at 570°C. ; this consists of placing the work in suitable containers in air-circulating tempering furnaces, heating to 570°C. held for 2½ hours, removing and allowing to cool to room temperature, this being repeated three times.

Drills are tested for hardness upon the 'lands', and a Vickers Hardness Tester must be used for this work because of the difficulty of supporting properly on a Rockwell type machine. One or more drills are checked from each batch.

The tangs of taper shank drills are toughened in molten lead and the drills are then sandblasted to clean and give the finish that appears most attractive.

Centreless and Relief Grinding; Pointing

Plain and centreless grinders (Fig. 5) reduce the drills to the required size and checkers are kept very busy in the grinding room ; a finished cutting drill point is ground, and the jobber drills are then stamped with the finished size.

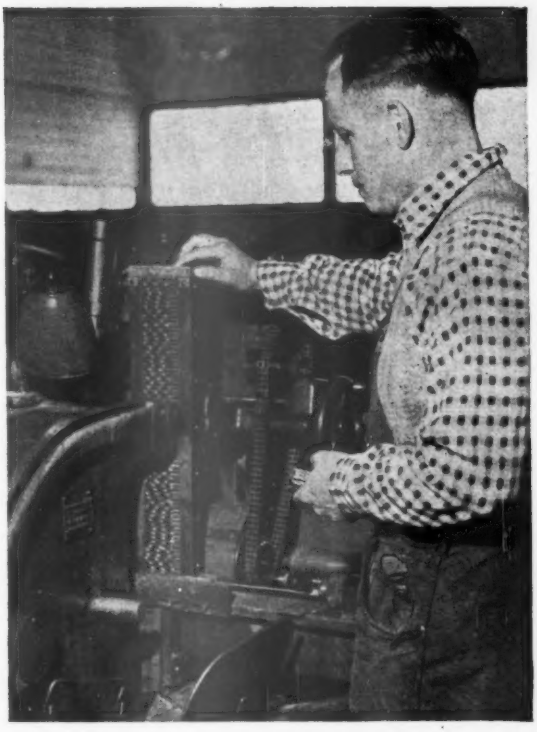

Fig. 5. Loading magazine for Churchill centreless grinding machine to feed 30/40 drills per minute. The control wheel is cammed and grinds one drill each revolution.

The relief grinding of smaller drills is done on a specialised machine of very simple but effective design. This machine has a light bracket that swings from a location below the grinding wheel carrying a guide with a location pin in towards the centre of the wheel and correct position is repeated by the aid of stops. The drill having been pushed through the guide to a stop to give length of relief, the bracket swings forward to a stop and the drill is slowly withdrawn, keeping the flute against the locating pin ; the grinding wheel removes metal to the amount the machine is set, pressure on the bracket is then released, drill indexed and the cycle repeated. The relief grinding operation is now complete. There must be a fine grain fairly hard wheel to give a good finish and not too much wheel wear, but it must also cut freely without burning or overheating; to achieve this, gashes are cut with a splitting wheel into the wheels cutting right through the face on the outside diameter to about 1" deep, giving at least seven serrations for a 6" diameter wheel and more for the larger. This has exactly the same effect as larger grain size in causing the breaking up of the cut.

It is of interest to note that we have found a mixture of common washing soda and water is the best coolant for drill relieving. The soda water allows a good grip to be taken for withdrawing the

Fig. 6. Screw extractor set.

drill and no trouble with rust is experienced if the density of the soda is kept constant. Twenty pounds of soda are used to 140 gallons of water, this mixture being constantly pumped through all machines.

For the extra small drills we heat treat blanks, grind to size, then grind the flutes from the solid taking a number of cuts, indexing after each cut and a spark out gives us a perfectly balanced flute. These drills are all machine pointed.

Whilst on this small class of work, I would refer to the Paper presented by Mr. R. E. Andrews before this Institution last year, wherein was described a method of using a Cincinnati tool and cutter grinder as a centreless grinding machine with the aid of standard equipment for extra small work. We found that by utilising this method we were able to use wheels 1" thick, giving us the corresponding short work plate that definitely overcame difficulties experienced with 4" wide wheels doing 80 wire gauge drills on our smallest centreless grinding machine. The grinding wheel used was 6" × 1" × 1¼" bore 120 MV and for a control wheel 3" × 1" × ½" bore rubber-bonded ; we reduced the control wheel speed to 50 r.p.m. by using a combination of two heads of standard cutter grinding equipment. By this means, we have ground hardened high speed blanks to 0.004" diameter by ¾" long. We were starting to design a suitable small centreless grinder and Mr. Andrews' Paper came at a most opportune time.

Before leaving drills, some interesting types of specials are worth mentioning. A combination drill and reamer requires a narrow fluted drill body; for the drill portion the first ½" or whatever required length is reduced 1/64th under the remainder in which three reamer shape flutes are milled. This special then goes through all the usual drill processes, but we grind a relief on the drill portion and grind relief on each of the reamer lands as for a standard reamer with a 45° angle from drill to reamer for cutting purposes ; also a conventional drill point on the end enabling the required hole to be drilled and the reamer follows through. These, whilst being in general use for car components, etc., were also the answer to a maker of rotary clothes hoists, his problem being to get a good reamed hole after drilling pipe which by conventional drill then machine reamer, gave a very poor finish with a series of flats. With the combined tool, we had the drill portion long enough to finish drilling through both walls of the pipe before the reamer started, and this made the drill as a steady pilot for the first reamed hole which afterwards steadied the tool for the second.

For a drill 4' long we weld about 6" of mild steel to the high speed and complete the drill through all operations. We then hold the mild steel portion in one clamp and weld any length required of mild steel to it. Since no chilling takes place, it is only necessary to remove the welding fin and polish, no annealing being required. Other specials include left-hand drill, subland, and step drills.

Centre Drills

For centre drills, the drill and angle portion are ground together, the machine having one cam to give clearance to the angled portion and another to give clearance to the drill, both operating together.

Drill Testing

Performance testing of drills is carried out by all reputable drill makers, the first essential being that the drill performs as well or better than required by British Standard 328 : 1950. Besides testing penetration rates in the prescribed steel, it is necessary to check in steel with a higher tensile strength, this still being applied to standard drills.

Drills with special heat treatments are often required for drilling special steels, and where problems of this nature exist we are only too willing to assist the user by carrying out feed and speed tests and, if necessary, providing variations of flute shape, lead of helix and heat treatment. Although BS.328 calls for 9.1" per minute penetration rate for a ⅜" drill, feeds up to 24" are often obtained and 200% of the British Standard rates is our aim, regularly achieved. Small wire gauge drills have reached 18" per minute penetration rate. The laboratory, by micro-examination, can tell if a drill fails through over or under heating when hardened, or if the tempering could be at fault.

SCREW EXTRACTORS

Our development of manufacturing processes for screw extractors will no doubt be of interest. The extractor (Fig. 6) may be described as having serrations or shallow half-round flutes, in the form of a very coarse left-hand tapered thread which grips the

sides of a hole drilled into the screw to be extracted and, on being turned left, will remove the broken screw. The flutes were the problem for consideration and milling was ruled out because of estimated cost and expected difficulty of producing clean flutes without a milling burr. This left the rolling method, but the machine maker at that time said that no taper rolling could be done.

Rolling was adopted, however, and our method (Fig. 7) is a displacement process. The size of the blank controls the finished workpiece, which is supported on a rest between two cylindrical rolls on the same principle as a centreless grinding machine, and while rotating is subjected to pressure sufficient to generate the correct depth of form. To save costs in trial-and-error making of rolls, we made two rolls of lead, turning, boring, etc. to our estimate of the required design. They were then mounted on the arbors of our Steinle thread generating machine and brought together on to an approved master pattern screw extractor. After a number of attempts, a portion of each roll had a clear impression of the work and by using only that portion we rolled dried Plasticine which held the shape. From the results, we were fairly sure of success and with the data thus obtained we made our first rolls in metal, testing upon soft copper before hardening, and altering until we felt the best shape was obtained. These rolls were made from 18 : 4 : 1 high speed steel. To digress a moment, the lead rolls looked like normal steel and when they were finished with, were taken to an operator on the lead pot who duly wired and immersed them in the lead to 'let them back a bit'. He got the surprise of his life to find that the 'steel' rolls vanished!

Testing at our Research Laboratory proved that it is not desirable to use the biggest extractor when removing a broken stud, but to endeavour to have enough metal left to prevent the five lands of the extractor displacing a shell of metal and jamming the stud still further. An example test was upon $\frac{1}{2}$" Whitworth bolts, using a No. 4 Extractor, 35 to 40 foot lb. being the torque required to remove the bolt, but using the larger No. 5 Extractor, 65 to 70 foot lb. was required.

THREAD ROLLING

We have obtained up to a quarter of a million pieces from some of our thread generating rolls, which were still capable of further work.

For components with a slight tolerance in the pitch, one can very easily make replacement rolls from one master by the following method. It will quickly be found that rolls to produce a right-hand thread will make rolls for left-hand threads, therefore the approved master must be obtained. The size of the blank is determined, machined, and put on one arbor and the master roll on the other arbor. This is forced by hydraulic pressure and generates its form which, after the usual heat treatment and grinding, will in turn reproduce itself. The pressure required to generate 12 t.p.i. Whitworth form into a roll is 1000 lb.; for 20 t.p.i. Whitworth it is 500 lb. For generating the threads on carbon steel for making taps, 600 lb. pressure is used for $\frac{1}{2}$" - 12" Whitworth and for $\frac{1}{4}$" - 20 t.p.i., 300 lb.

Straight and diamond knurls of any number of lines per inch are just as easily produced on rolls. Our own rolls for this work are made from oil hardening steel and the life is still too far off to estimate.

On our machines we have diverted part of the lubricant flow from the rolls to each of the ball race arbor supports, and no further difficulty has been experienced, although previously flats were constantly wearing causing sizing trouble. The rate of rolling can be varied to suit various sizes and a wide range of materials including copper, carbon and high speed tool steels are easily rolled, but it is also claimed that Monel, high alloy steel, and Nimonic normally considered unsuitable for thread rolling can now be rolled.

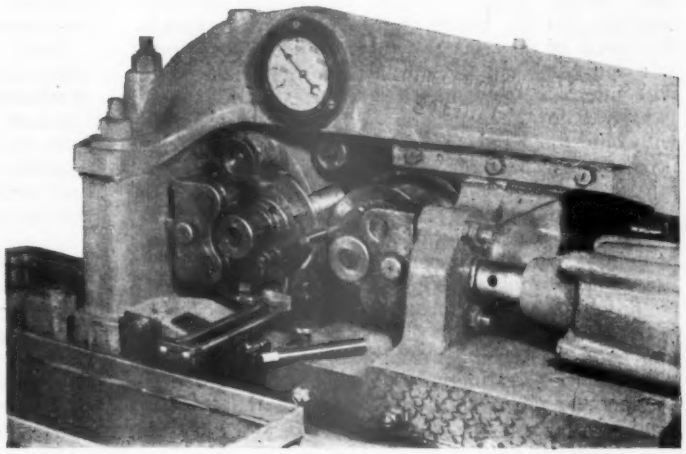

Fig. 7.

TAPS

In the manufacture of taps the most interesting method of producing the threads is by the form rolling process, the required quality and accuracy being easily achieved with the added advantage of high speed production. The resulting forms are strong because the material is caused to flow into its new form and the grain structure follows the thread contour and the finish is good.

The tap blank having had the shank reduced to size, squared and stamped, the portion to be threaded is centreless ground to a predetermined size just a few thousandths over the final effective diameter which divides the crest and root so that they are of equal area. The volume of metal is then moved from the root of the thread to form the crest by filling the form on the thread rolls completing the cycle in a few seconds. We roll threads from 10 B.A. (0.0669″) up to $\frac{7}{8}$″ Whitworth and 1″ Gas.

Taps of larger diameters, taper gas and coarser threads are thread milled. We have thread milling hobs with a width just clear of the tap thread end and on an automatic cycle the hob feeds in and cuts the thread, moving along by a cam action for a distance of one pitch of thread only; any required relief can be given per land, this being most important for the taper threads.

DIES

The thread milling machine, but with internal threading hobs, is used for threading pipe dies, the milling operation giving the clearance that testing has shown is most suitable. These pipe threading dies are now being supplied for 11 threads per inch with a two start thread lead previously only obtainable from the U.S.A.

In connection with dies, an operation of interest is the sawing-off of die blanks. The black bar of oil hardening steel is already cut into 20″ lengths and turned before the sawing operation. Suitable clamps have been designed, two of which are bolted to the milling machine table, one each end facing each other, and whilst one clamp is being loaded or unloaded the saws are cutting the bar on the other side. There is no backlash elimination on this machine, but the centre of the saws is near enough the centre of the work so we conventionally saw one side and climb cut the other. We use 8″ dia. saws with alternate teeth angled both sides at 45°, in a gang of 9 for 2″ metal and 13 for bars of $1\frac{1}{2}$″ dia., with only the standard drive on the machines. The arbor speed is 32 r.p.m. with a feed rate of 0.26″ per min.

In the milling section we have aimed for multiple operations using two jigs on a table wherever possible, enabling a load and unload whilst the second jig is in use. For example, drill tanging is two per cut and we flute four taps per operation.

On round or hexagon dies we face, chamfer, drill, and ream the core hole using a 5″ B.S.A. automatic machine on a continuous cycle. The loading of the air-operated chuck is timed on one of the capstan head advance strokes, the chuck opens, and a spring forces the completed blank out. A magazine is carried forward on the tool slide, and the arrangement is such that a plunger on the capstan head pushes a loading plunger in the base of the magazine and a blank is forced into the chuck which now closes; the magazine withdraws and the machining cycle continues.

The drilling of various chip clearance holes in dies is also done in multiples. We found that with the clearance holes in dies being so close together, little spindle strength would be left if attempting multiple hole drilling per die; it paid, with the strength of spindles and driving gears to withstand heavy speed and feed rates, to place four dies with a reasonably strong width of division, and by measuring that distance between the work, we obtained the necessary distance for spindle centre distances to enable one hole in each of four components at a time to be drilled, giving multiple hole drilling of four holes per cycle, or whatever number of holes was decided upon.

Parallel threading of the dies is done on a standard drilling machine using a long straight shank tap after the manner of a vertical tapping machine. We use neatsfoot oil as a lubricant and the addition of powdered sulphur prevents any inclination to 'pick-up' in the threading. A burring operation gives a clean cutting face to the lands in the dies and the cutting leads are milled at the correct angle for long and short leads. The previous tapping operation leaves in 0.002″, which material is now removed with a master tap, to give the required size. Stamping the necessary details, size, type of thread, number of threads per inch and the maker's name is the last operation before heat treatment.

For the heat treatment of carbon steels, there are oil-fired salt bath furnaces, designed to operate at temperatures up to 860°C, that being the required temperature for hardening a 1% carbon, 1.5% chromium oil hardening steel, from which we make a big percentage of our dies and taps.

After immersion in the liquid salt for a predetermined period, the components are quenched into an oil quench bath which is connected by an inlet and outlet to an underground 1,000 gallon tank some distance away. Constant circulation of the oil guarantees uniform hardening.

Tempering in air circulating furnaces comes next, after which components are tested on a Rockwell Hardness testing machine to see that the correct hardness has been attained.

In the case of button dies, the die is split where required with an abrasive wheel followed by discing and buffing to clean and polish. Taps are buffed on the shanks, ends, flutes and leads ground.

Inspection

Every component we make goes through our Metrology Department for inspection and checking to the appropriate standard required.

Drills are also visually examined for any errors in any of the operations, likewise taps, dies and our other items we manufacture are checked, before moving to packing and despatch.

Acknowledgments

The Author wishes to thank the Directors of Patience & Nicholson Ltd. for permission to present this Paper, and in particular, Mr. F. C. Warnecke for facilities in its preparation.

Many of the procedures and information described have been obtained through the co-operation and collective efforts of the staff at the Works, and also McPherson's Ltd., Testing and Research Dept., and thanks are recorded to all those concerned.

DISCUSSION

THE discussion was opened by **Mr. R. Deutsher,** who asked what percentage of tungsten was used in the normal Australian twist drill.

Mr. Taylor replied that most of the principal drill manufacturers in the world were using molybdenum high speed steel, which generally contained 6% tungsten. The American Cleveland Twist Drill Co. had used molybdenum high speed steel with great success for many years. Others would have made the change from 18% tungsten types much earler if sales resistance had not been built up during World War Two when, owing to shortages, orders for 18 :4 :1 type were part supplied with molybdenum high speed steel. The two steels required different heat treatment, meaning that if a production card was marked with the wrong type of high speed steel, the blame for the resulting scrap was always attributed to the molybdenum steel. Mr. Taylor's Company had changed from 18% tungsten to molybdenum type because (a) testing had shown that drills made from molybdenum steel gave excellent performance; (b) it was easier to machine ; and (c) it was cheaper.

Sir Fred Thorpe said that not so long ago, on jobbers (straight shank) drills, the sizes were branded in such a way that a burr was created on the shank, and consequently every drill ran out of true when put in the holder. Would Mr. Taylor kindly say what steps were being taken now to ensure that no burr was left on the shanks of straight shank drills?

Mr. Taylor replied that his Company's stamping machine allowed the drill to roll between two flat plates after marking the size, and this to a great extent reduced any burr. However, the problem still remained that most users desired to have the size clearly marked, so they compromised by aiming at a distinct marking, but one light enough to avoid throwing up a detrimental burr.

Mr. R. E. Andrews asked if some precaution would have to be taken to eliminate any swarf from the coolant used for cooling sleeves and bearings. With regard to the resharpening of form relief cutters, he asked what precautions were taken to ensure absolute concentricity and even shape of all the teeth.

Mr. Taylor replied that after use on special drill fluting machines, the soluble oil and water coolant returned by gravitation to a central storage tank, passing over a baffle plate, and through a fine mesh wire gauze, to be pumped to an overhead storage tank where further baffle plates settled any remaining foreign matter. The soluble oil mixture returned by overhead pipes to the various machines.

For centreless grinding machines, his Company used baffle plates and a magnetic filter to keep the metallic swarf from the grinding wheels. On thread rolling machines, the oil used was both for cooling and lubricating, and after use gravitated into the base of the machine over baffle plates to settle any swarf or foreign matter, and was pumped through a magnetic filter before using. No trouble had been experienced.

To ensure absolute concentricity with form relief cutters, the face of the teeth was ground from a constant diameter obtained by working with a fixed steel finger against the formed relief. Then, with the finger contacting the ground face, a small flat was ground on the relieved side of the teeth, which afterwards became the locating-spot when resharpening the cutter.

Mr. Ring said that on certain drawings from some of the big automotive companies in Australia, relating to high speed cutting tools, it was noticed that a treatment was specified to be applied after completion of the grinding operations. He understood it was very similar to anodising. Was this done in Mr. Taylor's Company?

Mr. Taylor said that the treatment consisted of nitriding, and was done on request. The hard skin formed overcame many difficulties, in particular showing to advantage on plastic and non-ferrous materials. However, it sometimes created trouble through brittleness and was not an answer to every problem. His Company had been testing oxide coatings on drills and found that a steam black finish gave improved drill life for most applications. Satisfactory results could often be obtained by varying the type of soluble oil.

Mr. Hansen, referring to point thinning, asked why this was not usually done by the drill maker.

Mr. Taylor replied that the web thickness of a new drill at the pointed end should be of a correct size suitable for use without any thinning, but since the web increased to the back of the drill, then after a few point regrinds the thinning was unnecessary. The drill manufacturer aimed to give a commercial point only because of the many materials to be drilled that called for various angles, such as the 130° for stainless steel, to the 60° for plastic. For every pointing machine sold to drill manufacturers, a large number were sold to drill users who must resharpen and thin the web as required. His Company pointed all very small drills.

Mr. C. Pullen asked if different drills were manufactured for different materials. He had in mind the high tensile aluminium alloys. Would Mr. Taylor recommend that there should be any difference to the standard point of 118°, or in the helix angle, and, particularly, what was the value of point thinning for such materials? He noticed, too, that in Mr. Taylor's Paper mention was made of the tempering of the high speed drills; they were tempered back at 570°C. three times. Could Mr. Taylor explain the reason for this?

Mr. Taylor replied that for high speed drills three tempers were given to make sure that the retained austenite had been transformed to martensite.

Different types of drills were manufactured for various materials, and for aluminium alloy he would suggest a flat point about 130° for deep drilling and somewhat sharper than the standard 118° for shallow work. The helix angle should be 33° to 46° compared with a standard of 25° to 32°, and instead of point thinning a 'crankshaft point' should be tried. This broke the chips and was a great deal stronger than the normal point.

Mr. Olsen said that in the automotive industry there was a certain type of drill with a small hole for coolant feed through the centre of the drill. How did they drill a spiral hole from one end to the other, or was it merely heated and twisted to the shape of the drill after the hole was positioned?

Mr. Taylor replied that the hole was drilled and the blank heated and twisted for most drills, but since they worked only from the solid, his Company's method was to mill a groove in the body clearance, then to insert a copper tube. This was just as effective and sizes down to $\frac{5}{8}$" diameter were regularly supplied.

Mr. Lang asked to what extent metric tap drills were in production in Australia.

Mr. Taylor said there was little request for them at the moment. The Wire and Letter Gauge, with the fractional size drills, give equivalents for most requirements.

Mr. McDonald asked how critical it was that the 118° angle should be controlled. Also, why should not a drill be parallel all the way along?

Mr. Taylor agreed that various amounts of oversize could be obtained by grinding a drill 'off centre'. The back taper was then of no value because the clearance was only given to prevent friction on the wall of the hole causing overheating, followed by pick-up, softening and rapid failure. Drills were, however, also required to cut to size, or at least within close tolerances, and it was then very necessary that .0005" to .001" per inch back taper required by British and American Standards be given.

Although drills were usually thought of as having two flutes, the back taper applied also to the three or four flute core drills used for enlarging, not originating, a hole, and the finish was of a high class when lining up or on interrupted cutting. The core drill with its bigger flute carried chips with ease.

Mr. Finch said he had experienced trouble in the machining of heat-treated nickel-chromium steels of tensile strength 160,000 to 200,000 p.s.i. Could Mr. Taylor say at what point the change should be made from high speed steel to tungsten carbides? It was a milling operation.

Mr. Taylor replied that he had had no experience with milling nickel-chromium steels, but the various steps taken with drills would be to obtain higher red hardness, by use of 22% tungsten high speed steel, followed by 5% or 12% cobalt. If all failed, then tungsten carbide could be used.

Sir Fred Thorpe asked if Mr. Taylor had ever had time to give some thought to the design or manufacture of the material from which centre drills were made, or some way of improving the facilities for centre drilling shafts in turning and grinding. It seemed to be a tool with a very short life.

Mr. Taylor replied that the centre drill was a combination small drill and coning tool, and this was sometimes overlooked, with disastrous results. The speed for the tool should be taken for the largest diameter to be coned and the feed per revolution should be based on those given in the usual tables of feeds for drills. He felt sure that with attention to those details, a longer life and satisfactory results would be obtained.

Sir Fred Thorpe wondered whether there was some particular relief on the cone which might provide the most steady support for the drill.

Mr. Taylor said that his Company had a radial relief grinding fixture which was easily adjusted to give any required relief. Since they did quite a lot of centre drilling, they were able to test until the best results gave the amount of clearance required, also the most suitable heat treatment. These results had been adopted for their standard production.

In reply to a question as to the advantage of a drill ground in the flute as against a drill not ground in the flute, **Mr. Taylor** said that the advantage of the polished flute was only for special applications. It could improve chip removal in some small diameter deep hole drilling; also, wood chips tended to flow more easily.

However, if the milled flutes had a good clean finish, top results could be obtained and there would be a risk of overheating the surface by polishing, with the subsequent danger of pick-up. Testing in his Research Department showed no advantage to be gained by polishing flutes for general applications.

REPORT OF THE MEETING OF COUNCIL

Thursday, 19th July, 1956.

THE first Council Meeting of the 1956/57 Session was held at 10, Chesterfield Street, London, W.1, on Thursday, 19th July, 1956. The meeting, at which the Chairman of Council, Mr. H. G. Gregory, presided, was attended by 24 members, and the following were present by invitation: Mr. A. Eustace, Hon. Secretary, South Wales Region; Mr. H. P. Sanderson, Hon. Secretary, Wales Region; Mr. H. B. Topham, Chairman, North-Eastern Region; and Mr. J. M. Steer, Member, Australian Council.

The Chairman welcomed the newly-elected members of the Council, and expressed his pleasure at seeing so many members of the old Council still serving.

Election of Vice-President/President-Elect

The Council unanimously adopted the Finance and General Purposes Committee's recommendation that the Right Hon. The Earl of Halsbury, F.R.I.C., F.Inst.P., be elected Vice-President and President-Elect of the Institution.

Co-option to Council of Mr. T. Fraser, C.B.E.

The Council unanimously adopted the recommendation of the Finance and General Purposes Committee that Mr. T. Fraser, C.B.E., be co-opted as a member of the Council.

Mr. H. E. Honer

On the motion of Mr. G. R. Pryor, seconded by Mr. J. D. Scaife, Mr. H. E. Honer was elected an Honorary Member, in recognition of the work which he had done in helping to establish the Institution.

Election of Standing Committees for 1956/57

The names of members elected to Standing Committees for 1956/56 appear on page 596 of this Journal.

Finance

It was reported by the Finance and General Purposes Committee that in accordance with the Council's recommendation that the membership subscriptions should be increased, an Extraordinary General Meeting of the Corporate Members was summoned (page 336 of the May Journal refers). There not being a full quorum present within 30 minutes, the meeting was adjourned in accordance with Article of Association No. 73. At the adjourned meeting on 21st June, 1956, the proposed increases were adopted.

Annual Dinner, 1956

It was reported that arrangements had been made for the Institution's Annual Dinner to be held at the Dorchester Hotel, London, on Friday, 5th October, 1956. The Minister of Labour, the Rt. Hon. Iain Macleod, had accepted the Institution's invitation to be Guest of Honour.

Production Exhibition and Conference, 1956

The Secretary reported that the Production Exhibition and Conference, which was held in the Grand Hall, Olympia, London, from 23rd to 31st May, 1956, had attracted a great deal of publicity in the lay and technical press and via the B.B.C. A total of nearly 5,000 people had attended the sixteen Conference Sessions. The Papers presented were published in the June, July, August and September Journals, and a separate report of the proceedings would also be available shortly, price 30/- per copy.

With regard to the 1958 Production Exhibition, the Council approved the Advisory Committee's recommendation that the Institution should sponsor this project on condition that the planning of the Exhibition was on a different basis, with a new theme as a result of experience gained from the first and second Exhibitions.

Department of Scientific and Industrial Research

Following the preliminary announcement that the D.S.I.R. was to be reorganised and managed in future by an Executive Council, the Secretary had written to the Marquess of Salisbury, Lord President of the Council, drawing his attention to the fact that within the membership of the Institution was a vast fund of practical experience, and offering to the Lord President any assistance which the Institution could render. In reply, the Lord President had expressed appreciation of this offer, of which he hoped to avail himself.

Regional Conferences

The Council were pleased to learn that the two Regional Conferences held during the quarter had been highly successful. The first, organised by the Midland Region, took place on 16th May at the works of the Austin Motor Company Ltd., by kind permission of Sir Leonard Lord, K.B.E., and the Company's directors. This Conference, numbering about 400 delegates, comprised the largest party ever received at Longbridge.

The second event was an all-day Conference organised by the North Midlands Region in Peterborough on 2nd June, when each Section in the Region was represented by a large contingent of members.

It was agreed that these two Conferences were an excellent demonstration of the benefits which could accrue from an intelligent use of the Regional organisation, and that they set a good pattern for future activities of this kind.

University Professors Conference, Delft

A delegation from the Institution, led by the Chairman of Council, Mr. G. R. Pryor, visited Delft for the Conference on the Teaching of Production Engineering Subjects from 22nd - 26th April, 1956. The Institution delegation was welcomed to the Academy of the Technological University at Delft and the formal sessions were held in the University Council Chamber. The Conference was joined by a number of leading University Professors from the Continent, and attempted to define the essential subjects for production engineering, together with their depth and content at University level. The Conference also discussed the contact between the academic and industrial sides of production engineering during University courses, and the composition of courses in technology and management. Visits were made to laboratories and workshops ranging from those specialising in workshop techniques, to advanced physics and management studies.

Summer School, 1956

It was reported that arrangements for the Summer School, to be held at Ashorne Hill from 25th - 29th July, were now complete. The evening addresses would be given by Sir Francis Simon and Mr. E. W. Hancock, M.B.E., President of the Institution, and daily lectures would be given by Mr. J. A. Sargrove, Dr. W. A. Chapman and Mr. T. Burns.

Membership

The Council approved a number of applications for membership and transfer, details of which appear on page 597 of this Journal.

Local Section Reports

The Council received a number of Regional and Local Section Reports, extracts from which appear on pages 598, 599, 600 and 603 of this Journal.

The Journal

The Editorial Committee reported that there had been a five per cent. increase in Journal printing charges, taking effect from 1st June, 1956, and caused by rising labour and paper costs. It had been agreed that the Journal printing contract should be renewed for a further three years.

As from July, a thinner and less expensive Paper would be used for the editorial content of the Journal.

The sale of advertising continued to be satisfactory.

Institution Papers

The following report was made by the Papers Committee :

(i) *The* 1956 *Sir Alfred Herbert Paper.* Arrangements were being made for this lecture to be presented by Dr. B. V. Bowden, Principal of the College of Technology, Manchester, on Wednesday, 14th November, 1956, in the Great Hall of the College. His subject would be " The Development of Technological Education in Europe, America and England ".

(ii) *The* 1956 *Viscount Nuffield Paper* would be presented by Dr. Grey Walter, of the Burden Neurological Institute, in the Lecture Theatre of the University of Bristol, on 17th October, 1956.

(iii) *The* 1956 *George Bray Memorial Lecture.* Arrangements were being made for this Lecture to be presented in Sheffield early in 1957, by Mr. Stafford Beer, whose subject would be " Operational Research ".

Institution Medal Awards, 1954 - 55

The Council approved the Finance and General Purposes Committee's recommendation that the following awards be made :

Institution Medal for the Best Paper by a Member to Mr. R. N. Marland, B.Sc., A.M.I.Mech.E., M.I.Prod.E., for his Paper " A Job-Evaluated Wages Structure ".

Institution Medal for the Best Paper by a Non-Member jointly to Mr. J. A. Stokes, B.Sc. and Mr. N. Milne, B.Sc., for their Paper " Electronics as an Aid to Production ".

The Hutchinson Memorial Award (for the best Paper presented by a Graduate of the Institution). No award was recommended.

The Lord Austin Prize (for the best Essay by a Graduate of the Institution) to Mr. Stanley A. Onions for his Essay entitled " Welding Distortion Problems Encountered in the Gas Turbine Industry ".

National Conference, 1957

The Council approved the Finance and General Purposes Committee's recommendation that the Institution's National Conference, 1957, be held at Harrogate from Sunday, 30th June, to Wednesday, 3rd July. Following the business of Council, there was a full discussion as to what the theme of this Conference should be, and a number of suggestions were put forward for consideration by the Advisory Committee.

Research

The following reports were made on behalf of the Sub-Committee of the Research Committee :

Materials Handling. The Sub-Committee had held their regular meetings in Birmingham. Arrangements for the Materials Handling Convention, to be held from 27th - 29th September, 1956, at Leamington Spa, were well under way.

The Materials Handling film show held in Birmingham on 27th March had been very well attended and the Sub-Committee had received a number of requests from Sections asking for assistance in planning lectures and film shows on materials handling subjects.

The Sub-Committee had discussed the Report of the Syllabus and Examination Working Group and a memorandum on the subject was being circulated to the Research, Education and Membership Committees.

Material Utilisation. Meetings had now been held by the respective panels and notes for the guidance of Sections willing to help in the preparation of Case Studies for the Final Report were being prepared and would shortly be circulated. It was hoped to have Working Groups established throughout the various Sections of the Institution within the next two months.

Sources of Information. The work of revising the Directory was still in hand.

Control of Quality Sub-Committee. A new Sub-Committee was being formed, and a Chairman was being sought to replace Mr. Nixon, who had resigned, although he would still continue to serve on the Committee.

Joint Research Committee. Two meetings had taken place with the I.C.W.A. It had been agreed that a representative of each association's Research Committee should be invited to attend each other's meetings when appropriate.

Two projects were at present in hand, namely, "Electronics and Kindred Modern Developments as Applied to Process Loading" and "The Effective Use of Shiftworking". A third project "The Efficient Utilisation of Capital in Industry", was being considered.

Standardisation

The Standards Committee reported that a second Conference of Standards Engineers, arranged in collaboration with B.S.I., had taken place in May and was attended by over 100 Standards Engineers. The Chair was taken by Mr. R. E. Mills, Chairman of the Standards Committee and the main address was given by Professor Martin, of the Rensslaer Polytechnic Institute, New York, on "The Standards Engineer and Economic Production".

A Sub-Committee had been investigating the need for revising B.S. 1866, dealing with Cutting Tool Nomenclature, and were now preparing a final report and recommendation.

The Committee continued its routine work of commenting on Draft Specifications and appointing Institution representatives, by invitation, to B.S.I. Technical Committees.

Hazleton Memorial Library

The Chairman of the Library Committee, the Rt. Hon. Lord Sempill, reported that there had been a great increase in the number of enquiries received, many of them from non-members and from other organisations. It was increasingly obvious that the publication of the Library Catalogue had been a most useful step and had enabled members to make much fuller use of the Library.

The Committee were grateful to 13 Sections of the Institution who had so far agreed to co-operate with the Committee by appointing Corresponding Members.

Sections Outside the United Kingdom

The Chairman said it gave him great pleasure to welcome two distingushed visitors from outside the United Kingdom — Mr. R. A. P. Misra, of Bombay, and Mr. J. M. Steer, of the Australian Council, and he invited them to speak.

Mr. Misra said that members in India greatly appreciated the work which had been done by the Institution and the extension of its activities in India through the Calcutta and Bombay Sections. Members in those Sections would warmly welcome the opportunity of meeting any members from the United Kingdom, even if they were only in India for a short time.

Mr. Steer said he had been asked by the President of the Australian Council, Mr. J. N. Kirby, to convey the greetings of Australia to the Council. Mr. Steer wished there were more opportunities for Australian members to attend the London Council Meetings, for he had found his own attendance most educational.

In Australia the Institution was well accepted by industry and it was gratifying to see the increasing number of affiliated firms. The three Sections in Melbourne, Sydney and Adelaide were all very active and looked forward to visits from United Kingdom members; they would be most welcome.

Honours

Members of the Council were pleased to learn that Her Majesty the Queen had conferred the following awards on members of the Institution:

Knight Bachelor

G. H. Dowty, M.I.Prod.E.

C.B.E.

R. M. Currie, M.I.Prod.E.

M.B.E.

A. H. Selby, A.M.I.Prod.E.;
A .W. Payne, A.M.I.Prod.E.

Obituary

The Council recorded with deep regret the deaths of the following members:

Member

W. P. Eastwood.

Associate Members

D. Fraser Brown; L. C. Hubbard; L. Shepherd.

Graduate

L. R. Kent.

Affiliate Representative

N. C. Robertson.

The Chairman referred in particular to the sad loss which the Institution had sustained by the passing of Mr. W. P. Eastwood, who had done so much for the Institution and for PERA.

Date of Next Meeting

It was agreed that the next meeting of Council should be held at 10 Chesterfield Street, London, W.1, on Thursday, 25th October, 1956.

THE STANDING COMMITTEES 1956-57

Finance and General Purposes Committee

The Principal Officers:-

The President, E. W. Hancock, M.B.E.
The Vice-President, The Rt. Hon. The Earl of Halsbury, F.R.I.C., F.Inst.P.
The Chairman of Council, H. G. Gregory.
The Vice-Chairman of Council, A. F. Kelley.

E. Percy Edwards, J. E. Hill, Sir Walter Puckey, E. F. Gilberthorpe, G. R. Pryor, R. H. S. Turner

Editorial Committee

The Principal Officers
J. M. Brice, A. A. Francis, M. J. Sargeaunt, E. G. Brisch, H. P. Jost, M. Seaman

Papers Committee

The Principal Officers
A. Betts Brown, A. A. Francis, H. P. Jost, J. M. Brice, K. J. Hume, J. C. Z. Martin
(In addition, each Section Committee is asked to nominate a representative to serve as a "Corresponding Member").

Education Committee

The Principal Officers
W. G. Ainslie, H. W. Hodson, B. E. Stokes, J. A. Bailey, K. J. Hume, E. Walshaw, F. W. Cooper, C. L. Old, F. Woodifield, E. P. Edwards, R. Ratcliffe, M.B.E., T. B. Worth, J. France

Hazleton Memorial Library Committee

The Principal Officers
L. W. Bailey, H. L. Madeley, The Rt. Hon. Lord Sempill, A.F.C., H. A. Chambers, R. C. Renton, D. C. Harrison, R. V. Rider, S. R. Smith, J. Irwin, M. J. Sargeaunt

Membership Committee

The Principal Officers
J. A. Bailey, E. P. Edwards, K. J. Hume, J. D. Berry, W. N. Ellerby, R. D. Owen, A. Betts Brown, W. H. Folds, J. A. W Styles, F. C. Cooke, J. L. Gwyther, F. Whitehead, G. H. Crump, H. W. Hodson, F. Woodifield

Standards Committee

The Principal Officers
R. K. Allan, B. Rule, J. A. W. Styles, D. B. Ibsworth, T. A. G. Sparling, R. J. C. Whitaker, J. Harris, H. Stafford, J. H. Winskill, R. E. Mills, F. J. Staddon, W. E. Wright

Research Committee

The Principal Officers
W. G. Ainslie, P. H. W. Everitt, S. W. Nixon, L. W. Bailey, J. F. W. Galyer, A. P. Oppenheimer, L. R. Beesley, R. S. Hind, S. G. E. Nash, B. H. Dyson, P. Holmes, A. G. Pate, T. W. Elkington, C. F. Hurst, P. J. Shipton, F. G. S. English, B. G. L. Jackman, W. J. Webb, R. M. Evans, R. N. Marland

ELECTION AND TRANSFERS—*(continued from opposite page)*

TEES-SIDE SECTION

As Graduate
J. E. Francis.

WEST WALES SECTION

As Student
G. I. Williams.

WOLVERHAMPTON SECTION

As Associate Member
J. Dunning.
As Graduates
G. F. Cook, A. E. Cook, R. H. Turner.
As Students
H. N. Summerfield.

Transfers
From Students to Graduate Members
G. V. Rutter, L. A. Dando, A. Hoyle, A. B. Jones.

YORKSHIRE SECTION

As Students
R. A. Weston, J. D. Moore.
Transfers
From Graduates to Associate Members
K. A. Asquith, T. Rippon.

NO SECTION

As Graduate
A. M. Constantinou.
As Students
W. T. Whitfield.

Transfers
From Graduate to Associate Member
R. R. Spilman.
From Student to Graduate Member
J. U. Grubb.

WESTERN SECTION

As Member
W. C. Glanfield.
As Graduates
A. D. Cross, H. C. Barnett.
As Student
D. H. Coombe.
Transfers
From Students to Graduates Members
H. Fass, G. N. Butler, F. S. Darling.

ELECTIONS AND TRANSFERS

19th July, 1956

BIRMINGHAM SECTION

As Member
A. C. C. Moore.
As Associate Member
D. A. Tilt.
As Graduates
R. A. Boyce, W. G. T. Thomas.
As Student
R. J. Clarke.
Transfers
From Graduates to Associate Members
R. W. Collins, M. H. Dowler.

BOMBAY SECTION

As Associate Member
H. K. Firodia.
As Associate
D. P. Basu.
As Graduates
M. N. Lokur, N. Swaminthan.
As Students
L. R. Sukhiga, T. L. I. Sankaranarayanan, V. Chandrasekaran.
New Affiliated Firm
ACBI Ltd.

CALCUTTA SECTION

As Graduate
S. P. Ray.
As Student
S. Singh.
Transfer
From Associate Member to Member
K. C. Mitter.

COVENTRY SECTION

As Members
J. Buckman, W. R. Perkins.
As Associate Member
H. Horne.
As Student
M. Smith.

DERBY SECTION

As Graduates
D. A. Rutherford, L. Wilson.
As Students
I. A. Neish.

Transfer
From Students to Graduate Members
W. Allen, R. A. J. Smith.

DUNDEE SECTION

Transfer
From Associate Member to Member
J. N. Low.

EASTERN COUNTIES SECTION

As Members
E. W. Cuthbert, H. V. Fisher.
Transfers
From Graduate to Associate Member
F. E. Nichols.
From Student to Graduate
J. C. Taylor.

GLASGOW SECTION

As Associate Member
D. S. Ross.
As Graduates
R. L. N. Black, I. M. Zelman.
As Student
D. C. Wood.
Transfers
From Associate Member to Member
W. T. Baird.
From Graduates to Associate Members
H. B. Rogers, J. A. P. Ross.
From Student to Graduate Member
P. G. Jenkins.

HALIFAX SECTION

As Student
L. Wright.
Transfers
From Graduates to Associate Members
A. L. Nelson, J. Taylor, J. Whitehead.

LEICESTER SECTION

As Graduate
C. Allen.
As Students
J. C. Hebbes, J. S. Hawkins, S. K. Maini, H. R. Moss, A. Poleck, A. A. Shumsheruddin.
Transfers
From Associate Member to Member
L. S. Pitteway.
From Students to Graduate Members
J. M. Smith, D. Taylor.

LINCOLN SECTION

As Graduate
D. L. Stockdale.

LIVERPOOL SECTION

As Students
J. L. Hignett, M. E. Whitaker.
Transfers
From Students to Graduate Members
W. P. Davies, A. J. Porter.

LONDON SECTION

As Members
L. Cooper, J. B. Friend.
As Associate Members
J. H. Hayes, J. T. D. Holt.
As Graduates
J. F. Aylott, R. V. Baron, R. J. Hill, E. Rath, A. F. F. Webb.
As Students
J. E. Bridger, D. G. Bucknall, P. E. G. Casemore, R. I. Cathcart, R. W. Joel, T. J. Smith, E. Spittle, M. A. Tinley, P. W. Wilkinson.
Transfers
From Associate Member to Member
L. W. Nickols.
From Graduates to Associate Members
F. L. Brodie, T. G. Howe, F. H. Johns, E. C. Lucking, C. Winstanley.
From Students to Graduate Members
J. R. Burton, R. P. Brackenbury, R. W. Martin, W. M. Stern.

LUTON SECTION

As Graduate
T. C. Forecast.
As Student
S. G. D. King.
Transfers
From Associate Member to Member
W. Edwards.
From Graduate to Associate Member
G. F. Meades.

MANCHESTER SECTION

As Associate Member
S. Corns.
As Graduate
D. M. Gupta.
As Student
S. J. Roberts.
Transfer
From Graduate to Associate Member
S. W. Whittington.

MELBOURNE SECTION

As Graduate
K. Pollitzer.
Transfers
From Associate Member to Member
A. G. Jones.
From Graduates to Associate Members
E. R. Cope, D. Cass, A. L. Reid.
From Student to Associate Member
L. J. McLean.
New Affiliated Firm
Watts, McRitchie Engineering Co.

NORTH EASTERN SECTION

As Graduate
J. F. Hedley.
As Student
K. Harkness.
Transfers
From Associate Member to Member
W. Hirst.
From Graduates to Associate Members
R. J. Currie, L. Taylor, G. D. Robson.

NOTTINGHAM SECTION

As Student
P. J. Ellis.
Transfer
From Student to Graduate Member
E. Reynolds.

PRESTON SECTION

As Member
R. J. Milburn.
As Associate Member
G. E. Turner.
As Graduate
R. J. M. Watt.
As Students
A. Leach, A. M. Marshall, P. Yarwood, D. Beesley.
Transfer
From Student to Graduate Member
J. Cartwright.

READING SECTION

As Graduate
R. L. Withers.
Transfer
From Graduate to Associate Member
P. H. F. Burton.

SHEFFIELD SECTION

As Student
D. W. Cotterill.
Transfer
From Associate Member to Member
C. B. Hoole.

SHREWSBURY SECTION

As Student
I. D. Jones.
Transfer
From Graduate to Associate Member
F. T. James.

SOUTH AFRICA

As Members
K. G. Eckford, J. Sutherland, A. L. A. Viner, E. A. Waetzel.
As Associate Member
J. G. Pattie.
Transfer
From Associate Members to Members
R. W. Chapple, T. H. Hunter.

SOUTH ESSEX SECTION

As Member
J. J. P. Hanaway.
As Associate Member
E. R. Easman.
As Graduate
N. R. P. White.
As Students
M. L. Robinson, D. G. Roberts.
Transfers
From Graduate to Associate Member
W. D. C. Huskisson, P. A. Taylor.
From Student to Graduate Member
N. A. Simmons.

SOUTH WALES SECTION

Transfer
From Graduate to Associate Member
W. M. R. Bell.

SOUTHERN SECTION

As Students
C. Foster, A. J. Morris, P. A. Ross.

STOKE-ON-TRENT SECTION

Transfer
From Associate Member to Member
B. E. Hackley.

SYDNEY SECTION

As Member
E. W. Cox.

(continued at foot of facing page)

EXTRACTS FROM LOCAL SECTION REPORTS

Presented to Council, 19th July, 1956

EAST & WEST RIDINGS REGION

Sheffield

In line with the East and West Ridings Region declared policy of improving the liaison between technical colleges, universities, industrialists and the Institution, and the advancement of technological education, the Sheffield Section Committee has suggested to the educational authorities that short special courses on various statistical methods would be most useful to management personnel.

The Section Committee were pleased to hear of the reconstitution of the Material Utilisation Sub-Committee and the Section Chairman has circulated a letter defining the terms of reference, and suggesting that interested members should attend a special meeting in an effort to provide case studies in the various fields. Already there has been an encouraging response, and a meeting will be arranged in the near future.

Yorkshire

Arrangements are well in hand for the syllabus for 1956/57 and also progress has been made in the liaison between the Institution, the Technical College and Leeds University.

The Annual Golf Match against the Leeds Association of Engineers was arranged for the 12th July, and the competition for the Trophy will be played at a later date.

EASTERN REGION

Eastern Counties

The winter session of lecture meetings was concluded in March. Since that date the only Section activity has been an evening visit to the Cliff Quay works of Fisons Ltd., Ipswich, when an interesting time was spent touring the works and auxiliary plant.

An afternoon visit took place to the works of Ransomes, Sims and Jefferies Ltd., Ipswich, in June, when the members of the Section made an interesting visit to a new works.

Committee meetings have been held monthly to organise the programme for next winter, plan a day visit to London Airport in September and to deal with routine Institution matters.

MIDLANDS REGION

Birmingham

The Section meetings have contined to attract ever increasing numbers of members and friends. The Papers: "Latest Developments in Foundry Practice" by Mr. J. D. Berry, and following the Annual General Meeting, "Production from Bar Stock" by Mr. R. Jackson, both provided members with information of current interest.

A joint meeting with the Birmingham Productivity Association was held at Joseph Lucas Ltd. Well over 500 attended to see latest films on Automation and to hear a summing-up by Dr. T. U. Matthew.

At the Annual General Meeting Mr. T. W. Elkington was re-elected to office of Chairman for 1956/57. It was also announced that Mr. B. W. Gould would be retiring from the office of Section Honorary Secretary, and that Mr. A. C. Turner the retiring Graduate Section Chairman, would take over as Senior Section Secretary on 1st July.

The Section Summer Outing was a visit to the Lockheed Hydraulic Brake Co. Ltd., in July. The Directors invited the members to luncheon as guests of the Company after a tour of the factory. In the afternoon the members met in Coventry for tea and visited the Coventry Theatre.

An attractive programme for 1956/57 has been arranged.

The best wishes of the Section go with Mr. R. D. Guthrie who is leaving this country to take up an appointment with Radiation (New Zealand) Ltd. Mr. Guthrie has served some time on the Birmingham Section Committee and was formerly Graduate Section Honorary Secretary.

Birmingham Graduate

At the Graduate Papers Evening held in April, Mr. T. F. Percival, Graduate Member, won the Senior Chairman's Prize for his Paper entitled "Training in Industry". Mr. A. Lloyd-Morris was the runner-up. This meeting was held in conjunction with the Senior Section who acted as the judges. All the six Papers presented were of a high standard.

The Film Evening held in May was the most successful meeting of the session. Members' wives and ladies were invited and the films shown ranged from cocoa and chocolate manufacture to the testing and racing of a high performance sports car.

Two interesting works visits have been held since March, one to B.I.P. Enginering Ltd., Streetly, and the other to Smethwick Gasworks.

Two social events are to be held during the summer months. In July, a visit to the Midland Gliding Club, Long Mynd, and in September, a Car Rally.

Arrangements are well in hand for a Graduate Conversazione to be held at the Birmingham University in September this year. This function entitled "Auto-motion" will deal with the mechanisms used in automation, i.e., electronic control, hydraulic and pneumatic movement.

The Birmingham Graduate Section will be holding a National Graduate Convention in Birmingham during September, 1957.

NORTH MIDLANDS REGION

Regional Report

Since the last quarterly report, this Region has held a one-day Conference at Peterborough in June. In the morning members and their ladies visited one of the following works: F. Perkins Ltd.; Peter Brotherhood & Co. Ltd.; and the Newall Engineering Co. Ltd. The Conference, which commenced after lunch, was held in the Town Hall and was opened by the Mayor of Peterborough, and Mr. E. W. Hancock, M.B.E., M.I.Prod.E., President-Elect, was in the Chair. The subject for discussion was "Aspects of Automation" and the principal speakers were: Mr. A. Griffiths, O.B.E.; Dr. C. H. Edwards, M.A., F.T.I.; Mr. H. M. H. Fox, M.I.Mech.E.; Mr. H. L. Barman, M.A., M.I.I.A.; Dr. H. L. Haslegrave, Wh.Sch., M.A., Ph.D., M.Sc.(Eng.), M.I.Mech.E., M.I.E.E.

During the Conference the ladies were entertained by Hotpoint Ltd.

The Region are very grateful to the hospitality shown to members and their ladies by F. Perkins Ltd., and Hotpoint Ltd.

The Conference was a great success and full honours should go to Peterborough Section for making such excellent arrangements.

Lincoln

Owing to a one-day Conference, which was held in June at Peterborough, no works visits were arranged to take place before September.

The Section welcomes Mr. T. B. Row, of Foster Gwynnes

Ltd., Lincoln, as a member of the Committee. This is the first time a representative from these works has assisted Lincoln Section in this capacity.

At the last Committee meeting the members recorded their appreciation to Mr. Hind for his excellent work in this Section during his two years in office.

Nottingham

Since the last report the Section has held its Annual General Meeting and are happy to announce that Mr. T. G. H. Middleton has been elected Section Chairman for next session. Mr. Middleton has served on the Committee for some time and has always shown great interest in the Institution activities and under his guidance the Section should continue to grow. Tribute should be paid to the retiring Chairman, Mr. L. Shenton, who has worked very hard during the past two years, and the Section has profited by his wealth of knowledge of Institution matters, and his unfailing knack of doing the right thing at the right time.

At the invitation of the Management, members visited Crossley Premier Engines Ltd., Sandiacre, and spent a very enjoyable time. The Section was well represented by members, with their ladies, at the one-day Conference of the North Midland Region at Peterborough.

Following the usual custom there will be no further summer activities but it is hoped to open next session with a visit to a local works in September.

Peterborough

The highlight of the past quarter was the North Midland Regional Conference on "Aspects of Automation", which was held at Peterborough in June. Over 190 members and their wives were welcomed by Mr. A. Griffiths, O.B.E., Director and General Manager, at an informal reception given by Messrs. F. Perkins Ltd. Conducted tours were made of three city factories: Messrs. F. Perkins Ltd., Diesel Manufacturers; Messrs. Peter Brotherhood Ltd., Engineers; and Messrs. Newall Engineering Co. Ltd., Machine Tool Manufacturers. The ladies were taken on a conducted tour of the historical Peterborough Cathedral. They were entertained to lunch by The Hotpoint Electric Appliance Co. Ltd., and afterwards attended film shows and demonstrations of domestic appliances. After the tours the members lunched at Messrs. F. Perkins Ltd., where the Managing Director, Mr. Frank Perkins, made a short speech which was responded to by the North Midland Regional Chairman, Mr. A. S. Johnstone.

The Conference was held in the Ballroom of the Town Hall during the afternoon and the ceremony was opened by The Right Worshipful Mayor of Peterborough, Councillor J. W. Setchfield. Mr. E. W. Hancock, President-Elect of the Institution, took the Chair, and under his auspices five principal speakers addressed the Conference and replied to the respective discussions which followed.

The first speaker was Mr. A. Griffiths, O.B.E., who spoke on "Automation". This was followed by two Papers of a more technical nature on "Automation in the Textile Industry" given by Dr. C. H. Edwards, M.A., F.T.I., of Nottingham, and on "Drop Forging" by Mr. H. M. H. Fox, Director of Smith Clayton Forge, Lincoln. Mr. H. L. Barman, M.A., M.I.I.A., Executive Officer, Rolls-Royce Ltd., Derby, spoke on "Implications of Automation" and was assisted by Mr. A. G. Clark, Works Manager, Rolls-Royce Ltd., Derby. The remaining Paper was given by Dr. H. L. Haselgrave, Wh.Sch., M.A., Ph.D., M.Sc.(Eng.), Principal of Loughborough College, on "Education for Automation", who was assisted by Mr. J. France, also of Loughborough.

After summing-up the Conference Mr. E. W. Hancock thanked the speakers, the local firms for their hospitality, and all who had taken part and helped in the Conference. Mr. A. S. Johnstone then thanked Mr. E. W. Hancock for the amiable way he had taken the Chair. The Institution was also represented by Mr. W. F. S. Woodford.

After the Conference the members joined their ladies at the Angel Hotel, where a buffet was arranged.

The Conference was considered a huge success and might well go down in history as the occasion of the first constructive defence of the atomic age's new industrial revolution — Automation.

The arrangements for the 1956/57 programme are now well under way and it is hoped to provide a series of six lectures and two works visits in addition to the Annual General Meeting which will be followed by a film show.

NORTH WESTERN REGION

Regional Report

The North Western Regional lecture was held in April in the Great Hall of the Manchester College of Technology. Sir George Barnett, Her Majesty's Chief Inspector of Factories, gave a Paper on "The Factory Acts and How They Affect Engineering Establishments". The lecture was well attended and was followed by considerable discussion which was recorded.

In May, members of the Liverpool, Manchester, Preston and Stoke-on-Trent Sections enjoyed a Golf Match. The Regional Trophy was won by the Manchester Section. All present expressed sincere thanks to Messrs. Thompson and Rogerson, of the Preston Section, who made the arrangements for a most enjoyable day.

Liverpool

The Section held its most successful meeting in March when Mr. D. W. Collier, Director of Cadbury Bros. Ltd., talked on "Human Relations in Industry". Mr. Collier drew entirely on his own experiences with his Company, and a number of his remarks caused consternation as being departures from existing practices in this area. In particular, his references to the Personnel Department prompted a lively discussion. The attendance was 78 and was drawn from a wide circle of industry. Eight ladies were also present.

During this period arrangements are being made to invite the Secretaries and Chairmen of local branches of engineering Institutions, Associations, and Societies to a meeting to discuss liaison between the various activities. It has long been felt that there is a need for such discussion, particularly in regard to lecture meetings. Invariably dates clash with other interests and this is blamed for poor attendances. It is planned to discuss this matter and other topics and it is hoped that a meeting of this kind will have a lasting benefit.

Manchester

The Manchester Section completed its 1955/56 lecture programme prior to submision of the last quarterly report.

The Committee continues active in dealing with applications for membership, preparation of next year's syllabus and other routine business. The Manchester Committee wish to draw the attention to the Council of the following matters:-

Journal

The Manchester Committee consider that the Journal has now reached a very high standard and they wish that the Editorial Committee should be congratulated.

Membership Certificates

The Manchester Committee has compared the present form of certificate being issued to members with previous issues and considers that the comparison is unfavourable to the present issue.

Manchester Graduate

This Section is now preparing its programme for the coming session and hope to include lectures on the following subjects: "Inspection as a Management Function"; "Organisation and Production of a Fighting Vehicle"; "Design and Production of a '5' Screwcutting Lathe"; and a lecture on the education necessary for future engineers.

The latest works visit was to Ferodo Ltd., and the interest shown by the members was an incentive to arrange them more frequently.

The Committee for this next session was thought at one time to be nearing the minimum strength due to the transfer of some of its members to Associate Membership. Members willing to take their place have been found. A useful guide to finding interested members has been the Register System devised by the Midland Graduate Sections which has been employed ever since its conception.

SCOTTISH REGION

Dundee

The final lecture meeting was held during this quarter and dealt with education. Mr. H. Wyndham Badger, M.A., the Institution's Education Officer, gave a lecture on "Education for the Production Engineer". The number of firms who sent representatives shows the interest in the area for production engineering education and augurs well for the future.

Mr. Badger visited the Technical College, where he had discussions with Mr. C. G. Ferguson, Head of the Department of Mechanical Engineering, and Mr. J. Nicholson Low, Lecturer in Charge of Production Engineering; he also visited the Industrial Estate where he met the Industrial Relations Officer of Messrs. Ferranti and the National Cash Register, to the advantage of all concerned.

This month, Mr. Alexander Williamson, one of the founder members of the Dundee Section, retires from the office of Chairman. Mr. Williamson has devoted much of his time and energy to the development of Production Engineering in Dundee. The Committee, in particular, is deeply grateful for his enthusiasm, organisation and regular attendance at meetings.

SOUTHERN REGION

Southern

At the Annual General Meeting of the Section held in March, both the Chairman and Secretary were returned for a second year's term of office. The Committee were re-elected *en bloc*, with the addition of Mr. E. J. Hathaway.

The lecture programme for the forthcoming 1956/57 session has been arranged around the general theme "Materials" and it is hoped to cover all aspects, such as new enginering materials, new material working techniques and utilisation.

It is proposed to hold lecture meetings in outlying parts of the Section; Banbury, Aylesbury and Witney, as well as in Oxford itself.

The Oxford Section will be concerned with a social event in September when the Southern Regional Meeting will incorporate a tour of some of Oxford's most famous colleges and also a launch trip on the river.

WELSH REGION

South Wales and Monmouthshire

There has been considerable activity in the Section during the past quarter and much good work has been accomplished by the Section Committee to further the prestige of the Institution. The normal lecture programme has been extremely well attended and it is very evident that careful selection of lectures has achieved good results. It is also felt that the questionnaire circulated to all members of the South Wales Section will enable the Committee to cater for the preference of all members for the lecture programme for 1956/57.

The Government's appeal for greater educational facilities for training increasing numbers of skilled technologists has been actively pursued by the Committee. It has been very evident that there is a desperate shortage of skilled personnel in South Wales and, in spite of the offer of many inducements to possible candidates, many firms have been in danger of closing down due to this shortage. Recognising the urgency of the situation in Wales, a small Education Sub-Committee was formed, and a meeting with Mr. H. Wyndham Badger, and Dr. Richmond, Head of the Engineering Department, Cardiff College of Technology, was arranged. The serious shortage of technologists in South Wales was discussed and a meeting with industrialists sponsored by the South Wales Section of the Institution was held in May. Dr. Richmond gave a resumé of the need for expansion of technical education, especially in South Wales where the demand for technologists is very acute. He then gave details of a variety of courses which are available and which will enable participants to qualify for a Diploma. Membership of professional institutes and co-operation between technical colleges and industry were also features of Dr. Richmond's talk. Many leading technologists in South Wales had offered their services to teach students in view of the urgent need for the present and the future.

In view of its outstanding success the Committee feel that the interests of the Institution in South Wales have been furthered by sponsoring such a successful meeting.

SECTIONS OUTSIDE THE UNITED KINGDOM

Adelaide

Three lecture meetings have been held during the quarter, namely: "Highlights in Metal Finishing Development" by Mr. John Blanch; "Practical Approach to Factory Layout" by Mr. F. S. Ames, Methods Engineer, Chrysler (Australia) Ltd.; "Principles of Good Heat Treatment" by Mr. E. H. Francis, A.S.A.M., of the Weapons Research Establishment.

The total membership of the Section is now 58 and nine applications are in progress.

Three Section Committee Meetings have been held during the period under review. After nearly six years of valuable service to the Committee, the Treasurer, Mr. E. H. Smith, A.M.I.Prod.E., has resigned because of ill health and pressure of business. Mr. F. C. Hackworth has undertaken the duties of Treasurer for the remainder of the year.

Melbourne

The first meeting of the year was held in March when 70 members attended to hear Mr. H. le Cheminant, M.I.Prod.E., give a report on the Margate Conference. Mr. le Cheminant, former Chief Engineer of Government Aircraft Factories, recently returned from an overseas tour which included his attendance at the Margate Conference.

At the meeting in April, 83 members attended to hear a Paper on "Methods Engineering Economics" presented by Mr. J. Alford, Methods Engineer of C.I.G. Equipment. This Paper was well received and promoted a lively discussion. In May, 80 members were present to hear a Paper on "Modern Methods of Sheet Metal Forming". This was presented by Mr. R. Shultz, A.M.I.Prod.E., and dealt with a comprehensive range of sheet metal forming methods predominantly seen in the aircraft industry.

A works visit was held in April to the International Harvester Company, Geelong. 30 members attended and were shown over the mechanised foundry during the morning. Members were guests of the International Harvester Company to luncheon and during the afternoon were shown over the various machining and assembly operations in this country.

Melbourne Graduate

The Section has set off to a good start in 1956, the opening meeting being in the form of a film evening, when films were shown on the development work leading up to the manufacture of the Holden car by General Motors—Holdens Ltd., and "Air Parade", which dealt with the growth of the British aircraft industry, particularly in the field of civil aviation from the early biplanes to the modern Comets, etc.

In April a works visit was made to Trans-Australia Airlines at Essendon Airport, where about 20 members spent a very interesting evening observing the methods of preventative maintenance used in the Airlines workshops in the servicing of their aircraft. Another works visit was held in May to the Kirkstall Repco Ltd., associate company of Kirkstall Forge Engineering Co. Ltd., Leeds. After a talk by the Chief Metallurgist on the history and activities of both parent and Australian company, members were shown over the large machine shop, toolroom and drop forging shop. This visit was most interesting to the Graduates and Students.

Bombay

A lecture meeting was held in April when a Paper entitled "Automatic Management and Time Study" was read by Mr. H. C. Rammana, A.M.I.Prod.E. The meeting was well attended and the Paper interesting.

Quite a number of enquiries have been received concerning application for membership.

(*concluded on page* 603)

MATERIALS HANDLING

CASE STUDY No. 6.

A Simple Example of Materials Handling Applied to the Stores Process of Batch Counting.

The Company. A large Midland Company engaged in the light engineering industry and comprising several product divisions. The division where this particular scheme was introduced employs 50 to 60 people and manufactures flexible rubber hoses and steel tubing both in small diameters and in varying lengths. It is a Company policy to search continually for improvement in the handling of materials by the application of work study to new and existing jobs.

The Problem. Batches of varying quantities of rubber hoses and steel tubing are delivered to a store after inspection at the end of a manufacturing unit. They are housed in the store and subsequently issued for despatch to meet customers' orders.

It is important to Production Control to check the quantity entering the store and also to determine the quantity precisely for the payment of the operators who are on piece-work. The count is performed only once and it is considered that the right place for it to be performed is at the point of entry into the store. With the growth of the output of the division a quicker means was sought, coupled if possible with greater accuracy.

old method

Batches of tubes or hoses were passed by Inspection and handed into the store. These were hand-counted and checked against the Stores Inwards Note, placed in racks and when required for despatch, quantities were again counted out by hand, bundled up and issued to the despatch department.

new method

Batches of tubes and hoses are passed by Inspection and handed into the store. These commodities are now stored in standard bundles of 25, 50 or 100, according to size and weight. A "first" quantity of 25, 50 or 100 is hand-counted and placed on one side of a Comparison Scale. A quantity of components is placed on the opposite scoop of the scale. This machine is so calibrated that one component more or less than the hand-counted standard will cause a considerable deflection of the pointer from zero. The total batch is thus counted and the bundles are tied and labelled and placed in racks. Subsequent issues for despatch are immediately available as the quantities are already known.

Advantages of New Method

(a) Mechanical counting gives greater accuracy ;

(b) goods handled in large quantities (bundles) ;

(c) goods always ready for issue.

Cost Savings

Comparison machine costs £72.

Time study showed that four minutes per 100 components is saved ; which at the level of output at that time, produced a total savings of 46 hours per week, or the equivalent of one operator. This operator was transferred to fill a vacancy elsewhere and consequently the capital outlay was recovered in about three months, after which time the true saving is made.

news of members

Mr. H. F. Adams, Member, has been appointed to the Board of Directors of The Hotpoint Electric Appliance Co. Ltd., Peterborough, and is now Director of Manufacturing. He was formerly General Works Manager. Mr. Adams was Chairman of the Peterborough Section for the period 1954/56.

Mr. P. B. Higgins, Member, has now joined the Board of Messrs. Jonas Woodhead & Sons Limited. In addition to being Managing Director of the Yorkshire Engineering Supplies Limited, Mr. Higgins is a Director of George Beardsley Co. Ltd., Specialloid Limited, and The Aero Piston Ring Co. Ltd.

Mr. W. Udall, Member, has now been appointed to the Board of The Brightside Foundry and Engineering Co. Ltd. Mr. Udall will still retain his title as Chief Engineer.

Mr. J. C. Warren-Boulton, Member, has now joined the staff of The Stahlunion Company of London being responsible for the sale of machine tools mainly in India and Pakistan. Mr. Warren-Boulton was Honorary Secretary of the Calcutta Section from 1946 until 1954, where his work for the Institution was greatly valued.

Mr. D. B. Archer, Associate Member, has been transferred from the Gold Coast by his Company, H. H. Fraser & Associates (Pty) Limited, Industrial Consultants, and is engaged on applying a system of preventive maintenance and maintenance allowances to both underground and surface engineering departments of St. Helena Gold Mines Limited, S. Africa.

Mr. H. F. Chandler, Associate Member, has recently been appointed Production Controller at the Rochester Works of Messrs. Blaw Knox Limited.

Mr. J. Dougall, Associate Member, is now with the Scottish Machine Tool Corporation Limited (Glasgow), and is engaged on Design and Development.

Mr. M. F. Jones, Associate Member, is now Manager (W.3. Department), Bus Bar, Cable Trunking and Tubular Heater Department of Walsall Conduits Limited, West Bromwich.

Mr. A. McL. Knox, Associate Member, has been transferred from the Shell Company, Beirut, to the Shell Company of Turkey Limited, Beyogla, Istanbul.

Mr. Kenneth J. Roberts, Associate Member, has recently changed his appointment and is now employed by the Lago Oil and Transport Co. Ltd., Aruba, Netherlands West Indies., as an Engineer 'A' in the Equipment Inspection Group.

Mr. M. H. Soulsby, Associate Member, has now taken up an appointment as General Manager of the Charlton Works of William Jeves Limited, London.

Mr. E. R. Unitt, Associate Member, has relinquished his appointment with the Coventry Gauge & Tool Co. Ltd., as a Machine Tool Designer, and has taken up a position as Designer Draughtsman with Rolls Royce Limited, Derby.

Mr. E. F. Bradley, Graduate, has been appointed Production Manager of Fisher & Ludlow Limited, Materials Handling Division, Birmingham.

Mr. D. C. Clark, Graduate, has relinquished his appointment as Works Manager at E. J. Bowman (Birmingham) Limited, and has taken up an appointment as General Manager of Northern Radiators Limited, Leeds.

"THE CHALLENGE OF THE AGE"—*concluded from page 544*

Firstly, we must ensure that there are abundant and appropriate facilities for the education and training of the rising generation of Production Engineers.

Secondly, whatever our age, we must keep our own education up-to-date by keeping abreast of the latest progress in science and technology or, at least, to appreciate their importance.

Thirdly, we must be always on the alert to discover how scientific and technological progress can be applied to manufacture in the widest sense.

Fourthly, and probably the most important, we must study and apply the best practice in human relations not only in the factories that come within our influence, but with all groups of people who now influence industrial relations.

If we conscientiously discharge our duties to the best of our abilities in these directions, then we are entitled to the satisfaction of knowing that we have made a major contribution to the advancing well-being of our fellow men.

Hazleton Memorial Library

REVIEWS & ADDITIONS

Members are reminded that copies of the Library Catalogue may be obtained from the Librarian, price 2/6d., plus 4d. postage (price to non-members, 10/-, plus 4d. postage).

"Machinery's Screw Thread Book." 16th edition. *Brighton, Machinery Publishing Co. Ltd.,* 1955. 224 *pages. Diagrams. Tables.* 10s.

Since the appearance of the previous edition of this book was published a big step forward in the standardisation of screw threads has been brought about. Due to this, and, no doubt, to the appearance of a new author, the present edition has been entirely re-written and re-arranged.

The measurement of screw threads by the wire method has been treated much more extensively, whilst gauge tolerances, briefly dealt with in the previous edition, have been omitted altogether. The author feels that to do this important subject justice would require more space than was available.

The arrangement of this book is definitely improved, the subject matter being presented in a more orderly manner. This had been accomplished, firstly, by a complete orientation of the tabulated information, which incidentally consists of by far the major portion of the book and, secondly, by dividing the book into 11 sections. Seven of these sections deal with the various types of screw threads used in industry, and are as follows:-

Section A. British Threads of Whitworth Form. 28 pages, including 20 tables.

Section B. British Threads of non-Whitworth Form. 24 pages, including 18 tables.

Section C. Unified and American Series Threads. 22 pages. 17 tables.

Section D. American Translational Threads. 12 pages, including seven tables.

Section E. American Pipe Threads. 10 pages, including nine tables.

Section F. American Petroleum Institute Casing, Drill Pipe and Standard Tubing Threads. 24 pages, including 14 tables.

Section H. Horological Threads. 10 pages, including seven tables.

The measurement of screw threads by the wire method is comprehensively treated in *Section J* (30 pages, including 16 tables). This section includes matter on asymmetrical thread forms and taper threads. Numerous formulae are used, most of which are derived. Nut, bolt and screw dimensions are given in *Section K* (22 pages, including 20 tables). Tapping drill sizes for British, American and unified threads are tabulated in *Section L* (11 pages, including eight tables).

This edition of the book is enhanced by being provided with a stiff cover. Although it contains 224 pages compared with the previous edition's 168, a number of small interesting items have unfortunately been omitted, presumably to save space. L.E.C.

"The Book of the Lathe: a Practical Handbook for all Centre Lathe Users" by C. T. Bower. *London, Odhams Press,* 1955. 192 *pages. Illustrated. Diagrams.*

This is a very largely practical handbook, written in a style comprehensible to amateurs and machine operators. It does not pretend to go very deeply into machine tool design or the theory of machining, but it does contain numerous practical hints and ideas. In this respect it may be described as outstanding. It is hardly a reference book, but rather one that can be read from cover to cover by apprentices, keen amateurs and centre lathe operators; all these can find interest in it and can benefit by applying some of the author's practical ideas. J.C.Z.M.

SECTION REPORTS—*(concluded from page 600)*

Calcutta

At the Annual General Meeting held in March, Messrs. P. Bhattacharji and S. B. Bhattacharya were unanimously elected as Section Chairman and Section Honorary Treasurer respectively. Mr. C. K. Haldar was unanimously re-elected Section Honorary Secretary. Mr. B. F. Goodchild, who has held the office of Section Chairman for two consecutive years, was elected as a Committee member, also Messrs. S. S. Jauhari and S. Bhattacharya. The other members of the Committee are Messrs. S. R. Chatterjee, P. J. O'Leary and E. W. H. Scaife.

Three films entitled "The Lathe", "Plain Turning" and "Grinding Cutter-bits", received recently from the U.S.A., were shown in April. A talk entitled "What Psychological Tests Can and Cannot Do" was given in June by Dr. A. Edwin Harper, junior, M.A., Ph.D., Head of the Psychometric Unit of the Research and Training School, Indian Statistical Institute, Calcutta.

One Section Committee meeting was held during the quarter under review, but a Dinner arranged in April had to be postponed on account of an inadequate response from the local members.

COVENTRY ANNUAL DINNER-DANCE

The Coventry Section are holding their Annual Dinner-Dance on Friday, 12th October, 1956, at the Masonic Hall, Coventry. The reception is to be at 7.30 p.m. for Dinner at 8 p.m. Dancing will take place until 1 a.m., liquid refreshments being available until midnight.

Tickets are 30/- each, and may be obtained from W. P. Gill, c/o S. Gill & Sons (Engineers) Ltd., Lythalls Lane, Coventry.

ADDITIONS

Acton Society Trust, London. **"Management Succession : The Recruitment, Selection, Training and Promotion of Managers."** *London, the Society,* 1956. 139 *pages. Charts.* Reports the result of research into promotion policies and practices above the level of foreman in private manufacturing organisations with 10,000 or more employees. Chapters 1 and 2 survey the education and career of more than 3,300 managers ; chapters 3 to 6 discuss how 50 companies recruit, train and promote managers ; and chapter 7 records an attempt to discover what the promotion policies of five companies look like from the shop floor.

Aluminium Development Association, London. **"Aluminium in Contact with other Materials."** *London, the Association,* 1955. 46 *pages. Illustrated. Diagrams.* (A.D.A. Information Bulletin No. 21.) 2s. Brief notes on the nature of corrosive attack are followed by notes on the prevention of attack, and by accounts of the behaviour of aluminium in contact with other materials.

Aluminium Development Association, London. **"The Arc Welding of Aluminium."** *London, the Association,* 1955. 92 *pages. Illustrated. Diagrams. Charts.* (A.D.A. Information Bulletin No. 19.) 2s. 6d.

Aluminium Development Association, London. **"The Properties of Aluminium and its Alloys."** 4th edition. *London, the Association,* 1955. 204 *pages. Charts.* (A.D.A. Information Bulletin No. 2.) 7s. 6d. "Relates to the 1955 revision of British Standards for aluminium and aluminium alloys for general engineering purposes and incorporates . . . data for alloys as specified for aircraft use . . . and proprietary names under which compositions are supplied."

American Iron and Steel Institute, New York. **"Tool Steels."** *New York, the Institute,* 1955. 72 *pages. Illustrated. Tables.* (Steel Products Manual.) 2s. 6d. Identification and type classification ; selection ; tolerances and allowances for machining and decarburisation; macroetch inspection guides.

American Management Association, New York. **"Keeping Pace with Automation : Practical Guides for the Company Executive."** *New York, the Association,* 1956. 134 *pages.* 30s. "What effect will automation have on equipment, plant layout and manpower, and what are its implications for industry and society as a whole ?" The Papers are adapted from material presented at the A.M.A.'s conference on automation, New York, 1955. They include four reports of company experiences: electronic equipment manufacture ; coated abrasive manufacture ; food container manufacture ; and fruit juice processing.

American Management Association, New York. **"Tested Approaches to Cutting Production Costs : Overhead — Materials — Payroll."** *New York, the Association,* 1955. 125 *pages. Diagrams. Charts.* The Papers are adapted from material presented at the A.M.A.'s Special Manufacturing Conference, Cleveland, 1955. There are sections devoted to materials handling, clerical work, inventory management, maintenance and indirect labour.

American Society of Mechanical Engineers, New York. **"ABC Conference on Unification of Engineering Standards: Canada, United Kingdom, United States."** *New York, the Society,* 1955. 87 *pages. Diagrams.* $1.50. Abridged report of the conference which took place in New York, in April, 1955. Subjects discussed were: screw threads, bolt and nut dimensions, mechanical engineering terminology, surface finish, limits and fits, ball bearings and gauging.

American Welding Society, New York. **"Brazing Manual."** *New York, Reinhold ; London, Chapman and Hall,* 1955. 193 *pages. Illustrated. Diagrams. Table.* 38s. A comprehensive guide to the brazing of metal-to-metal assemblies, excluding jewellery applications, and assemblies with non-metallic components.

Baker, H. Wright (editor). **"Modern Workshop Technology." Part 1—"Materials and Processes."** 2nd edition—revised and enlarged. *London, Cleaver-Hume Press,* 1956. 35s. A considerable revision of the 1st edition. The new edition includes chapters on shell moulding, investment casting and on the production of steel wire. The chapter on plastics engineering has been entirely recast and extended.

Bristol and Bath Productivity Association, Bristol. **"What About Work Study ?" : an enquiry into its benefits and snags by a Bristol working party.** *Bristol, the Association,* 1955. 40 *pages. Illustrated. Diagrams.* The inquiry was mainly concerned with the difficulties and procedures involved when work study is introduced. Nine successful applications of work study are reported, which include the replanning of a composing room layout ; the reorganisation of a road van delivery service ; and a study of small batch production on jig-boring machines.

British Productivity Council, London. **"Work Study Aids Farmers : Case Studies Show How."** *London, the Council,* 1955. 6 *pages. Diagrams.* 6d. Case studies of cleaning parlour and dairy ; winter feeding of dairy herd ; and pig feeding and cleaning of piggeries.

British Electrical Development Association, London. **"Electric Motors and Controls."** *London, the Association,* 1955. 279 *pages. Illustrated. Diagrams.* Describes and discusses the various types of electric motors, and explains why a particular type is chosen for a particular job.

Council for Technological Advancement, Chicago. **"Automation and Job Trends."** *Chicago, the Council,* 1955. 24 *pages. Diagrams.* (Series on Technology and Employment No. 3.)

Dunsheath, Percy (editor). **"Industrial Research, 1956 - 57."** *London, Todd Publishing Group,* 1956. 444 *pages.* 63s. A comprehensive guide to government and other research organisations in the United Kingdom interested in industrial research. This, the third edition of a standard reference work includes a new section dealing with the work of the Atomic Energy Authority.

Hampel, Clifford A. (editor). **"Rare Metals Handbook."** *New York, Reinhold,* 1954. 657 *pages. Illustrated. Diagrams.* Data on the occurrence, extraction, physical properties, fabrication and application of 34 rare metals.

MacMillan, R. H. **"Automation : Friend or Foe ?"** *Cambridge, University Press,* 1956. 96 *pages. Illustrated.* The author illustrates the principles of control with familiar examples such as the pressure cooker, and cooking-oven thermostat. He discusses the advantages and limitations of automatic factories, and the methods that are used in their planning and control. A separate chapter is devoted to the development and applications of automatic computers ; and another to the social and economic aspects of automation. There is a good reading list. The book is a popular introduction to the many technical and quasi-technical subjects denoted by the word "automation".

Office Management Association, London. **"Clerical Salaries Analysis 1956, at at 1st March, 1956."** *London, the Association,* 1956. 78 *pages.* 78 *tables. Charts. O.M.A.'s Clerical Job Grading Schedule in folder at back.* The seventh analysis of clerical salaries carried out by the Association since 1942. Section A comprises Area Tables ; Section B, Industry/Area Tables ; Section C, Industry Tables with some breakdown into areas ; Section D, Salary Scales for Government and other large organisatoins. A summary of the findings is given on pages 9 - 22.

Scientific American. **"Automatic Control" :** A *Scientific American* book. *New York, Simon and Schuster,* 1955. 148 *pages. Diagrams.* Reprints of articles in the *Scientific American.* A survey of "feedback" and its applications to machine control.

Stout, Claude E. **"Shop Mathematics."** *New York, Wiley ; London, Chapman & Hall,* 1955. 282 *pages. Diagrams.* The book is arranged in four parts to meet the needs of a training programme for machinists, tool and die makers and pattern makers.

Venables, P. F. R. **"Technical Education : its Aims, Organisation and Future Development."** . . . . with five chapters by specialist authors. *London, Bell,* 1955. 645 *pages. Maps.* 42s. Surveys educational needs and facilities in the United Kingdom. The appendices form a directory to teaching institutions, examining bodies and professional associations. The four special chapters deal with engineering ; women's education ; art ; and commerce.

Wass, C. A. A. **"Introduction to Electronic Analogue Computers."** *London, Pergamon Press,* 1955. 237 *pages. Illustrated. Diagrams.* "A description of the principles of operation and design of electronic equipment which can be used to solve problems in dynamics and kinematics by the method of analogue computation." There are descriptions of a number of existing computers including "Gepus" and "Tridac".

Woollard, Frank G. **"Flow Production and Automation: Eighteen Axioms."** *Birmingham, Industrial Administration Group of the Guild of Students of the College of Technology, Birmingham,* 1956. 20 *pages.* 5s. The eighteen axioms are a summary of the author's main work "Principles of Mass and Flow Production", 1954.

INSTITUTION PUBLICATIONS

"The Automatic Factory — What Does It Mean?" Proceedings of the Margate Conference, 1955. Price 30/- from the publishers, E. & F. N. Spon, 23 Henrietta Street, Strand, London, W.C.2.

"So You're Going To A Meeting?" by Sir Walter Puckey. Price 5/4d. from the Publications Dept., 10 Chesterfield Street, London, W.1.

"Production Control and Related Works Statistics." Report of the Joint Committee of the Institute of Cost and Works Accountants and the Institution of Production Engineers. Price 5/- from Gee & Co. (Publishers) Ltd., 27/28 Basinghall Street, London, E.C.2.

"Material Utilisation in the Metal Working Industries." Report of the Material Utilisation Sub-Committee of the Institution of Production Engineers. Price 5/4d. from the Publications Dept., 10 Chesterfield Street, London, W.1.

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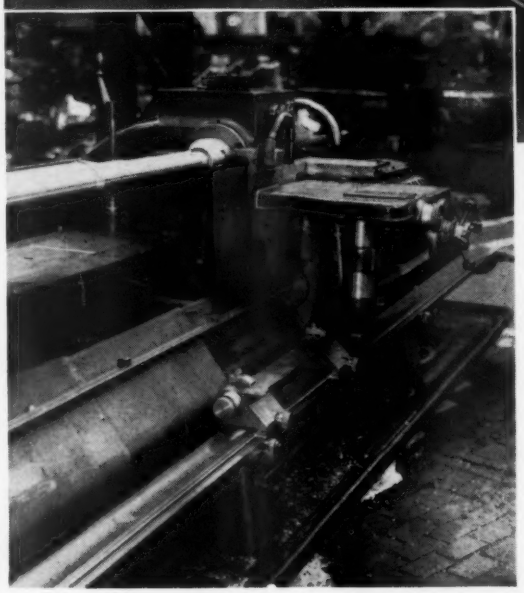

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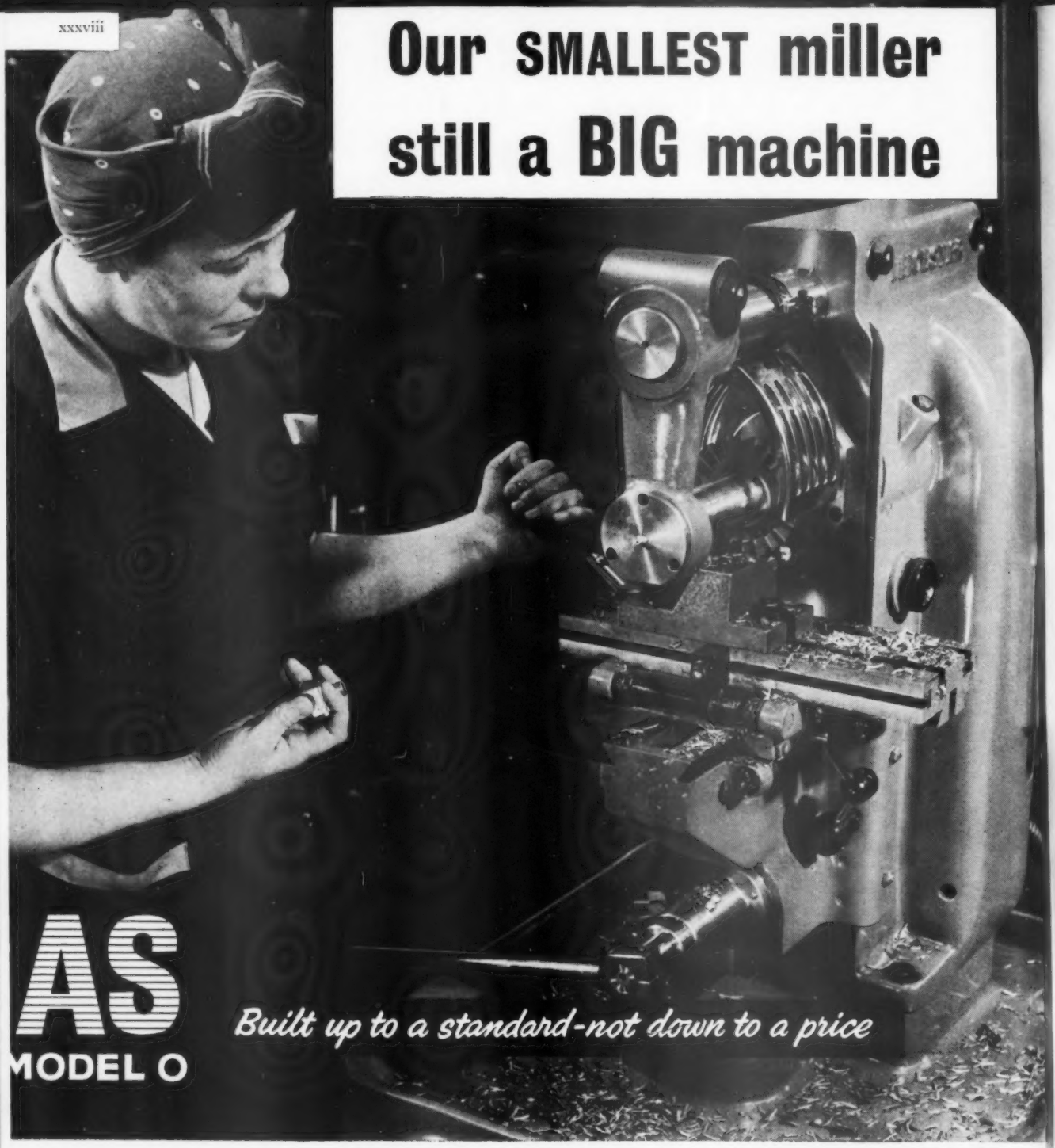

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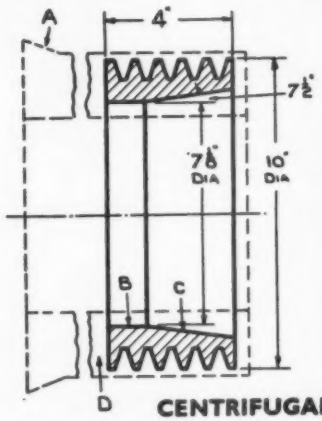
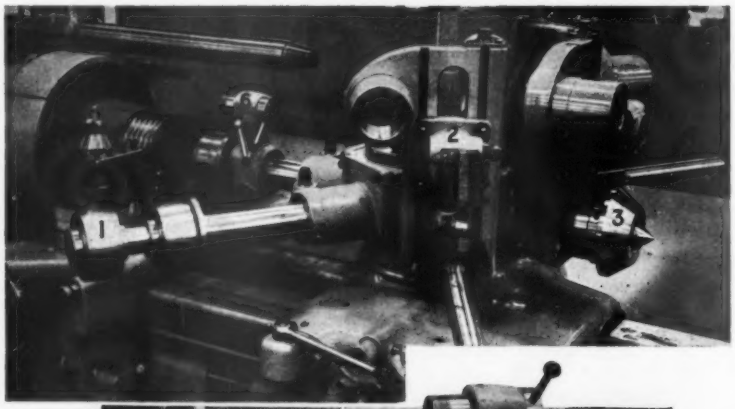


FITTED WITH 18" TUDOR CHUCK

All Tungsten Carbide Cutting Tools

DESCRIPTION OF OPERATION	Tool Position		Spindle Speed R.P.M.	Surface Speed Ft. per Min.	Feed Cuts per Inch
	Hex. Turret	Cross-slide			
Chuck (using Loader) at A	1	—	—	—	—
Rough Face End	—	S.T.1	125	335	84
Rough Bore B and C and Turn 10" dia.	2	—	125	325	84
Support and Rough Vee Grooves	3	Rear	40/24	110/60	246
Support and Finish Vee Grooves	3	S.T.2	75	200	Hand
Finish Bore B and finish Turn 10" dia.	4	—	125	325	84
Finish Taper Bore C	5	Rear	125	260	84
Chamfer Vee Grooves	—	S.T.3	125	325	Hand
Support (unloader) and Part-off D	6	S.T.4	59/75	150/200	176

CENTRIFUGALLY CAST IRON Floor to Floor Time: 28 minutes..



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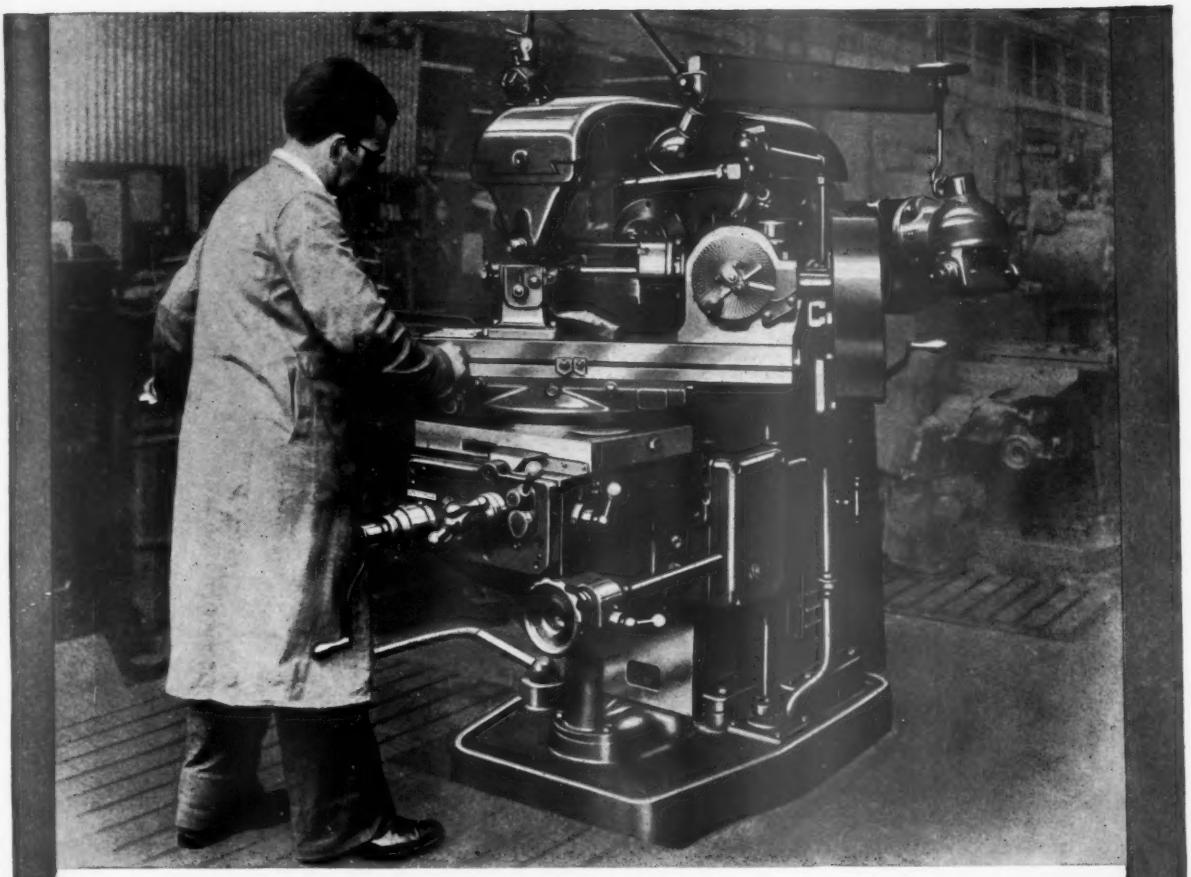

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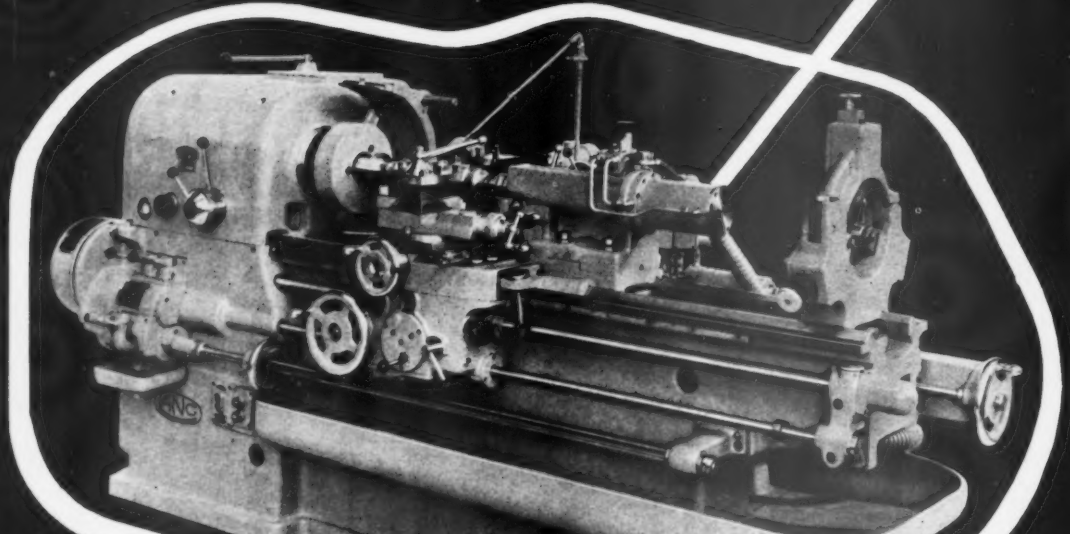
SIZES	2NU—UNIVERSAL	2NP—PLAIN	3NU—UNIVERSAL	3NP—PLAIN
Table	51 × 11½ ins.	51 × 12¾ ins.	60 × 14 ins.	70 × 16½ ins.
Longitudinal feed	28 ins.	30 ins.	36 ins.	40 ins.
Cross feed in line of spindle	10 ins.	10 ins.	12 ins.	12 ins.
Spindle speeds	12 rates, 29 to 775 r.p.m.	12 rates, 29 to 775 r.p.m.	16 rates, 29 to 775 r.p.m.	16 rates, 29 to 775 r.p.m.
Swivel Base Vise—Size	No. 26	—	No. 27	—
Width and depth of jaws	6 × 1¼ ins.	—	7½ × 2 ins.	—
Opening	3¾ ins.	—	5½ ins.	—
Floor space to cover movements	101 × 96 ins.	103 × 77 ins.	122 × 114 ins.	144 × 88 ins.

P365C

model J6



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Max. thread dia. (Int.) ...	2″	6″	16″
Length between centres	5½″	3′ 0″	2′ 6″, 5′ 6″ or 8′ 6″
Max. pitch cut	—	6 t.p.i.	2 t.p.i.

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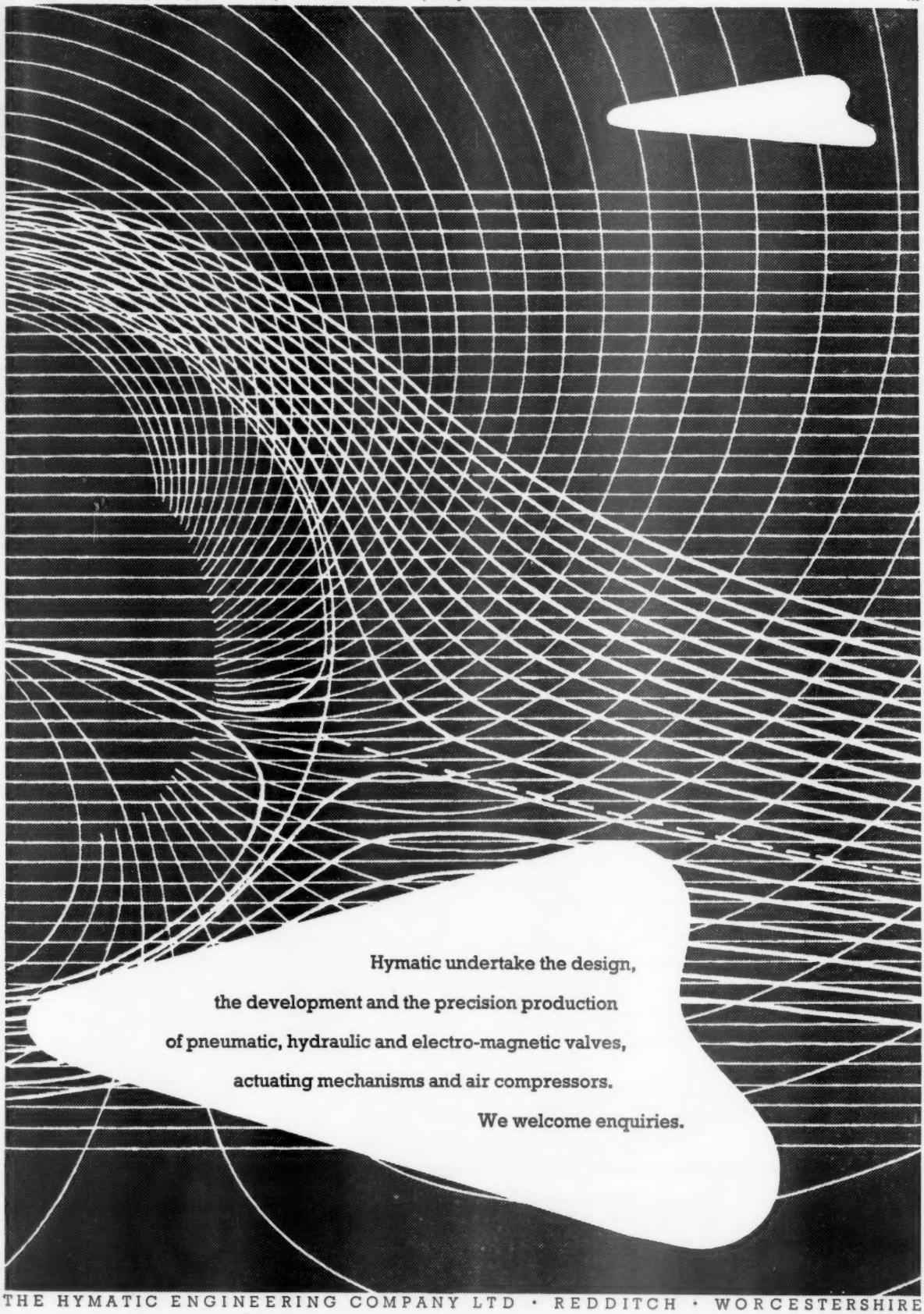
● *Design based on diagram of flow round cylinder with circulation, aerofoil sections and the stream lines.* 160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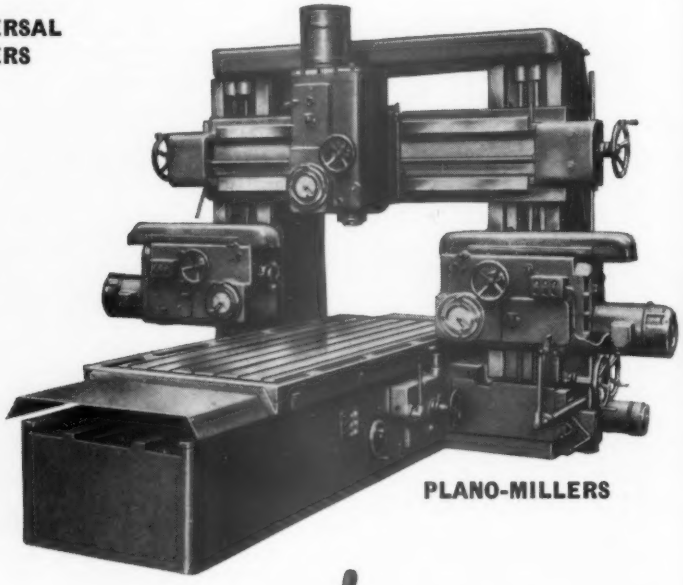

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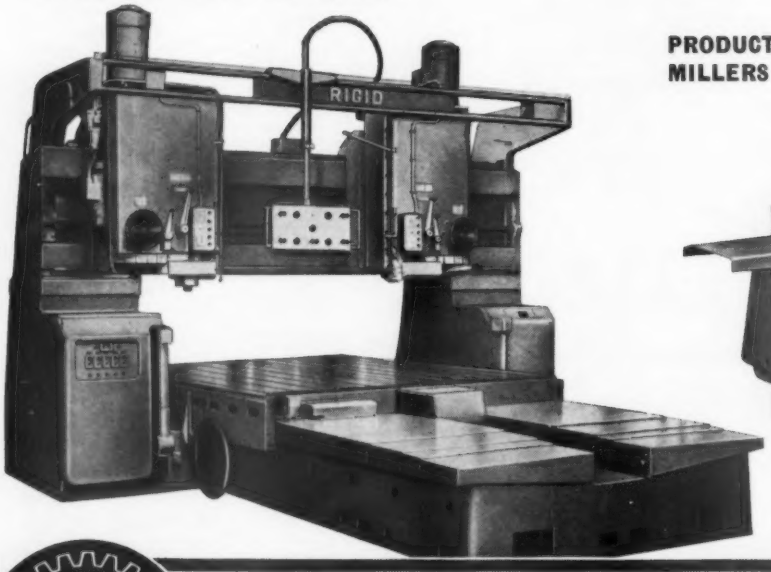

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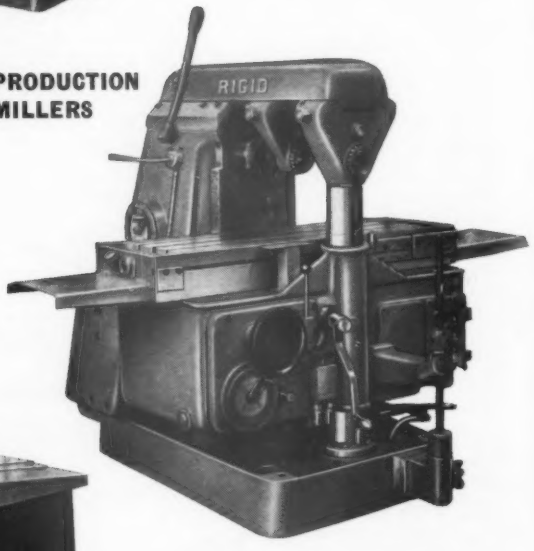

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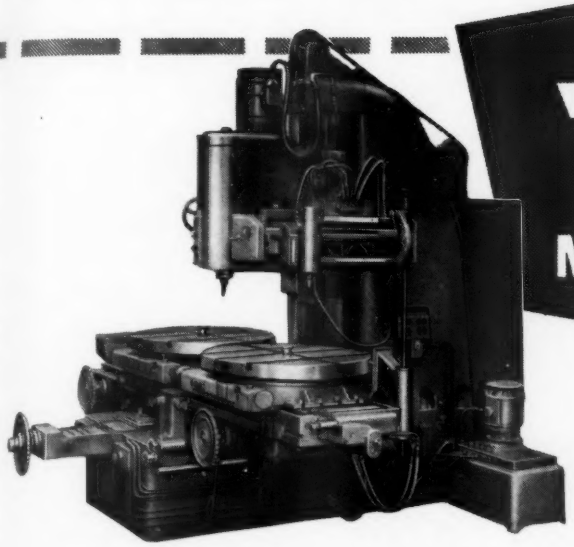

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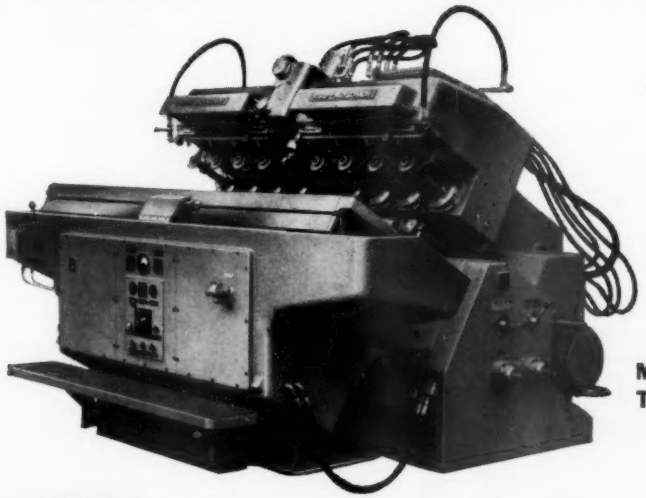

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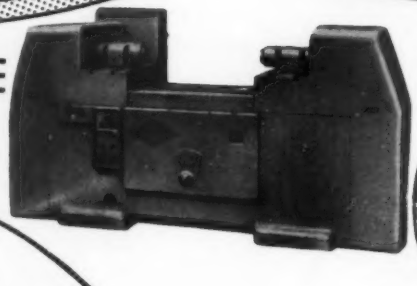

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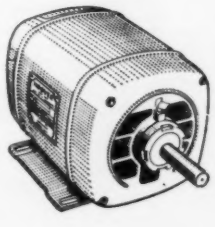

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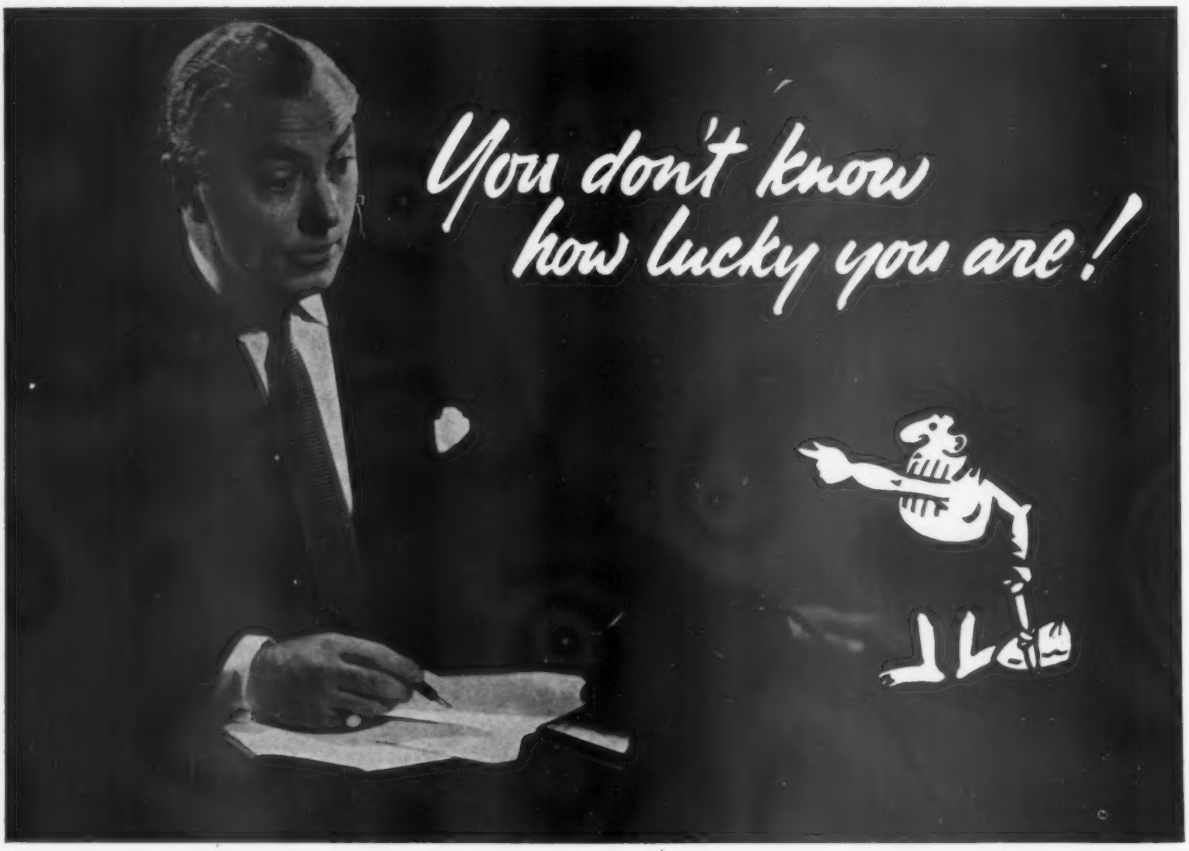

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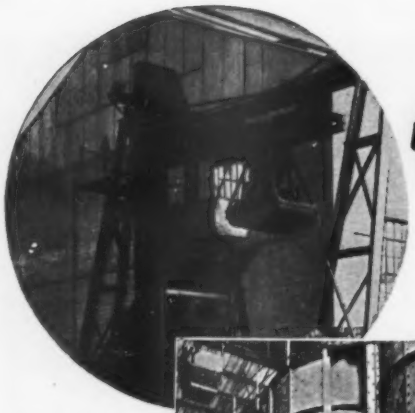

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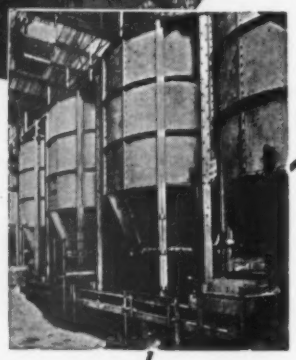

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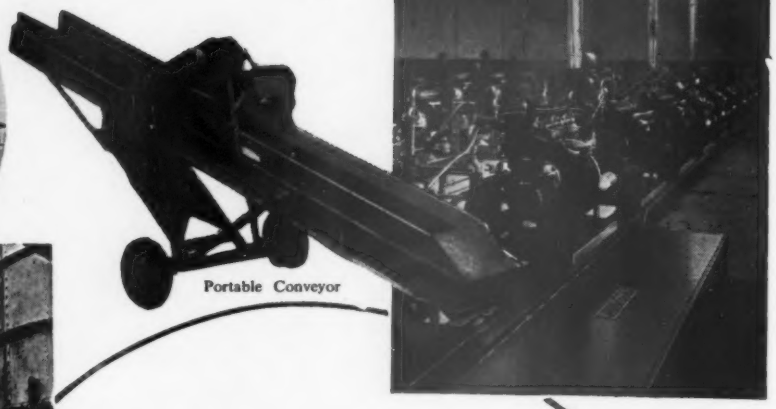

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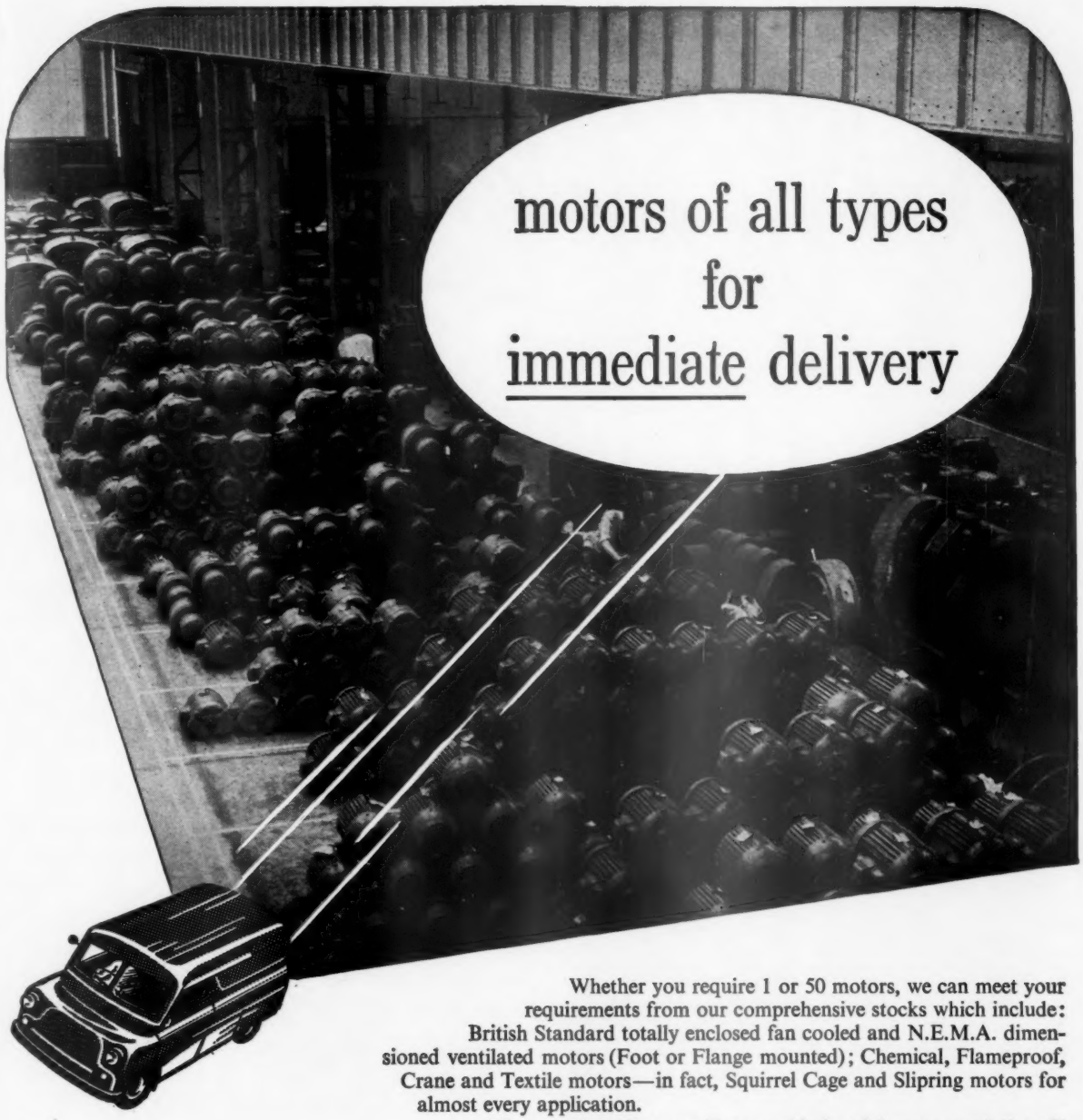

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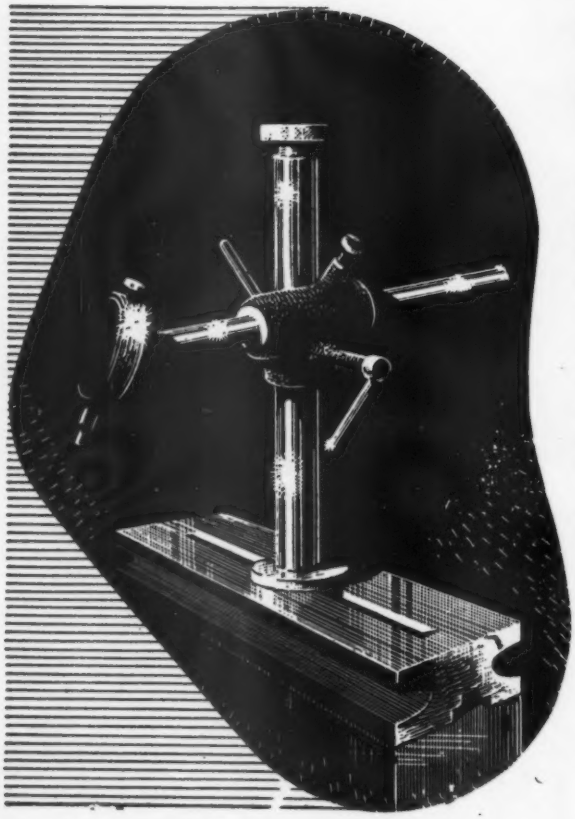

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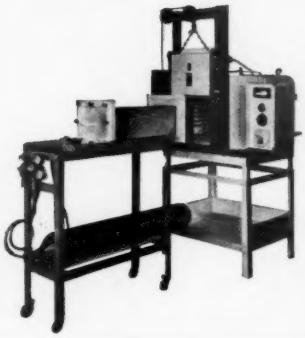

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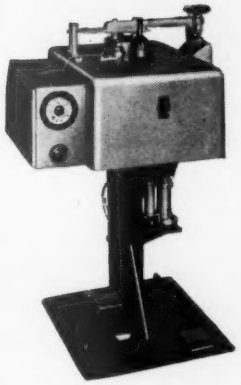

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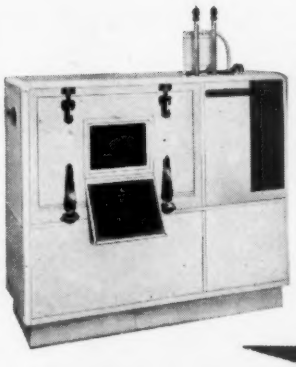

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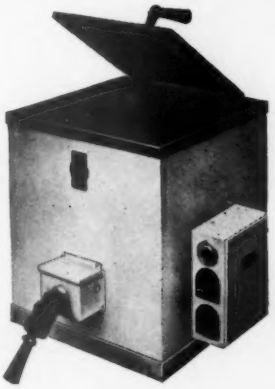

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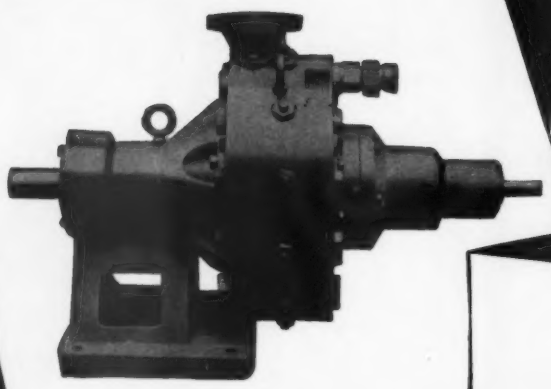

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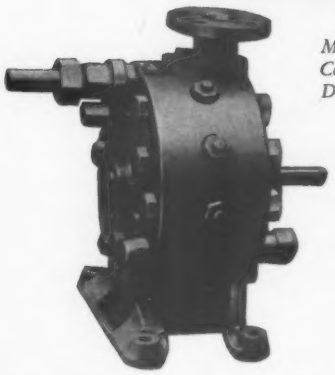

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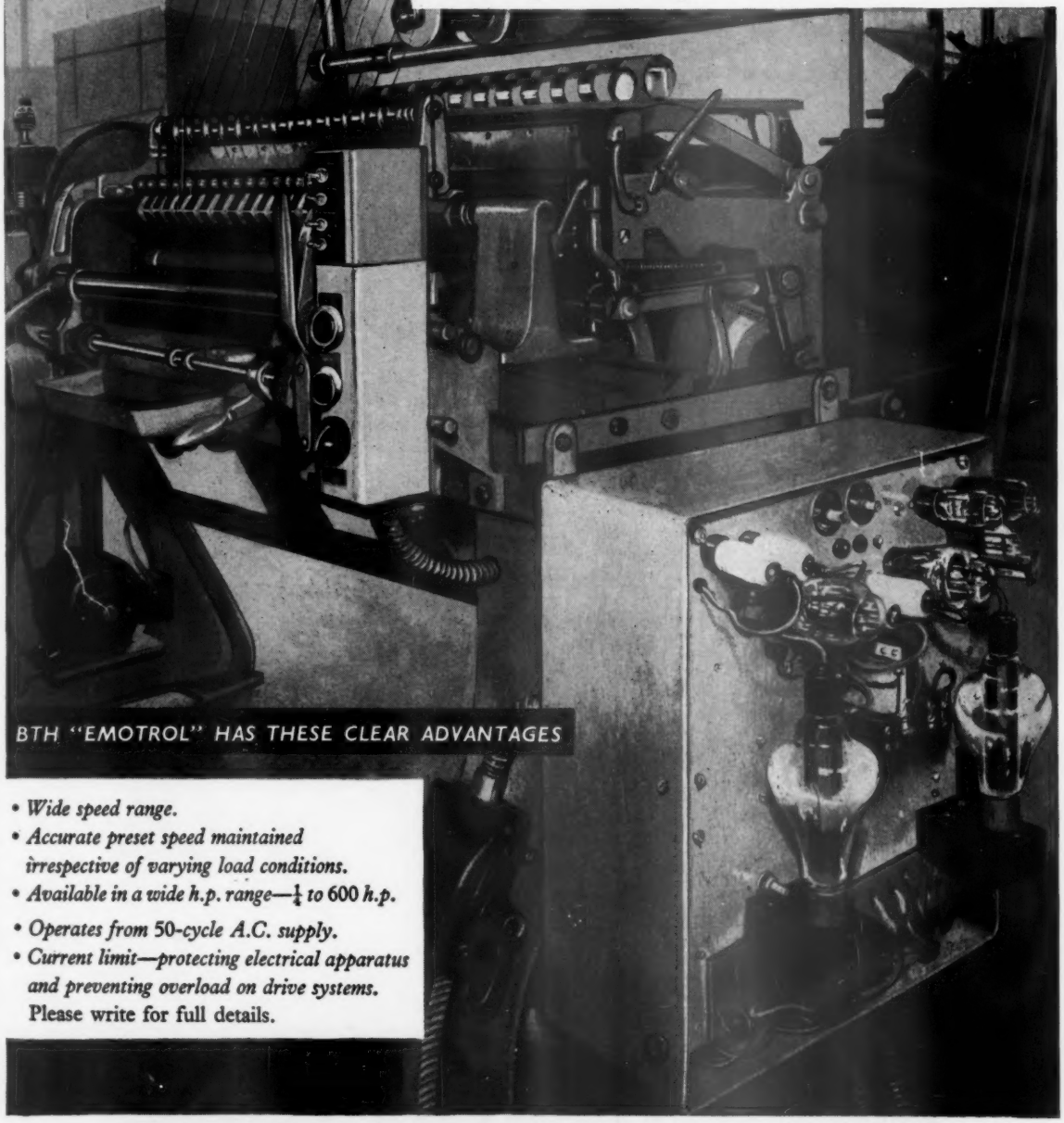

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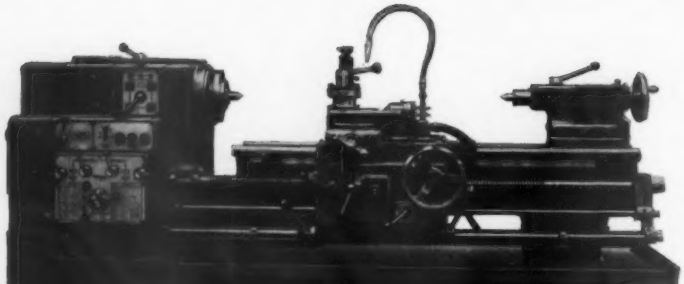

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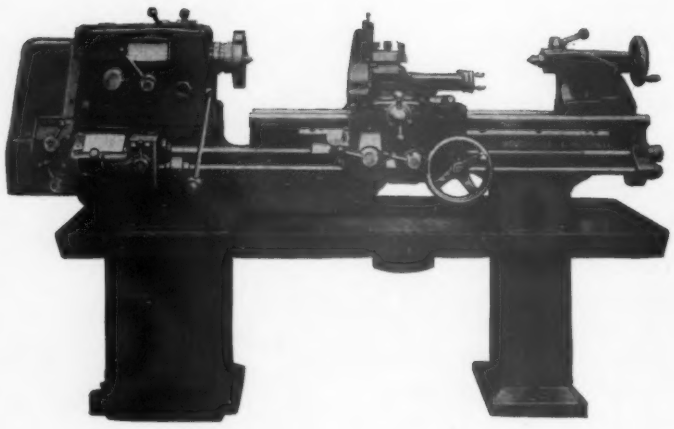

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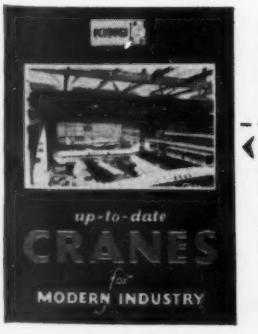

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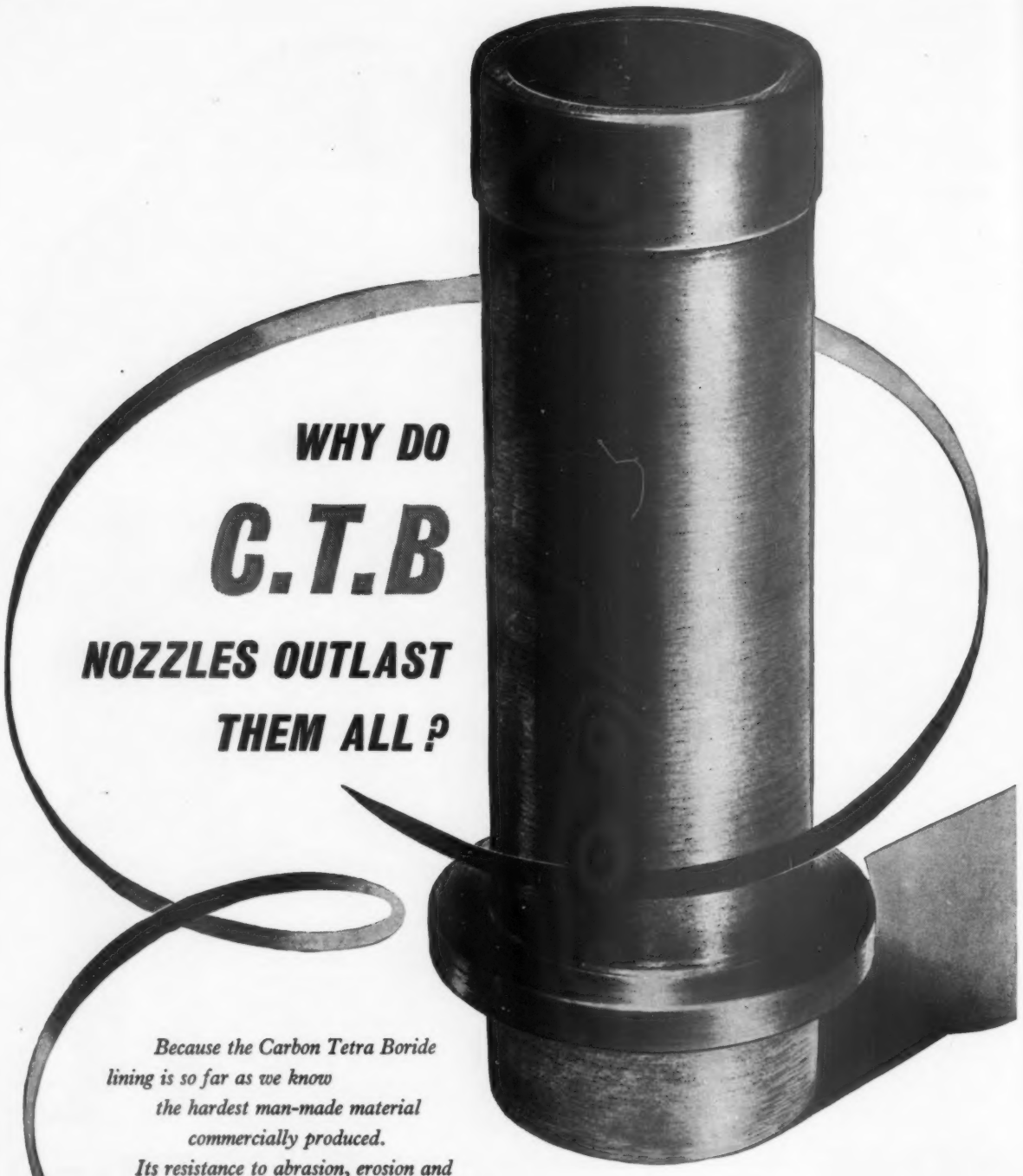

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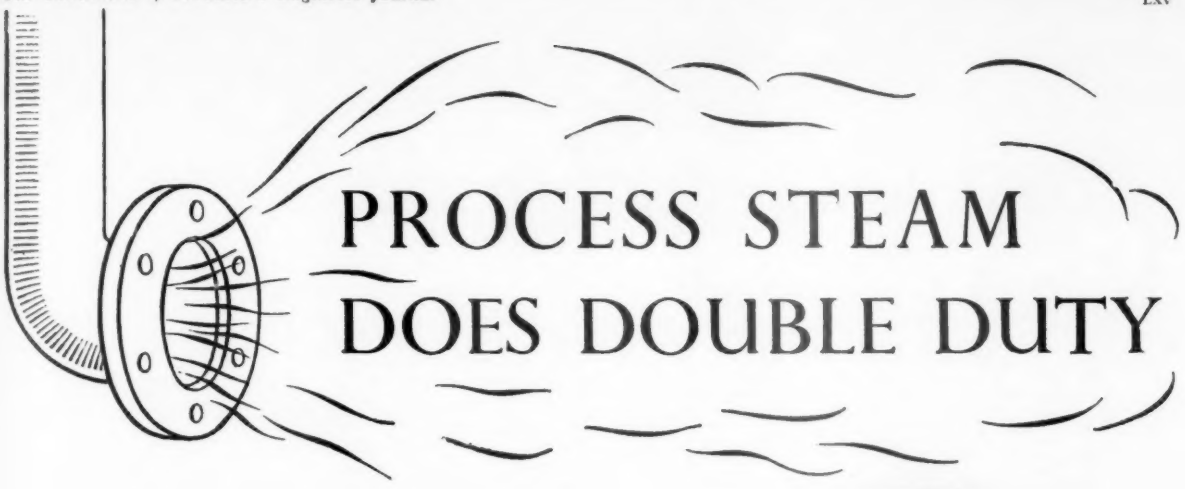

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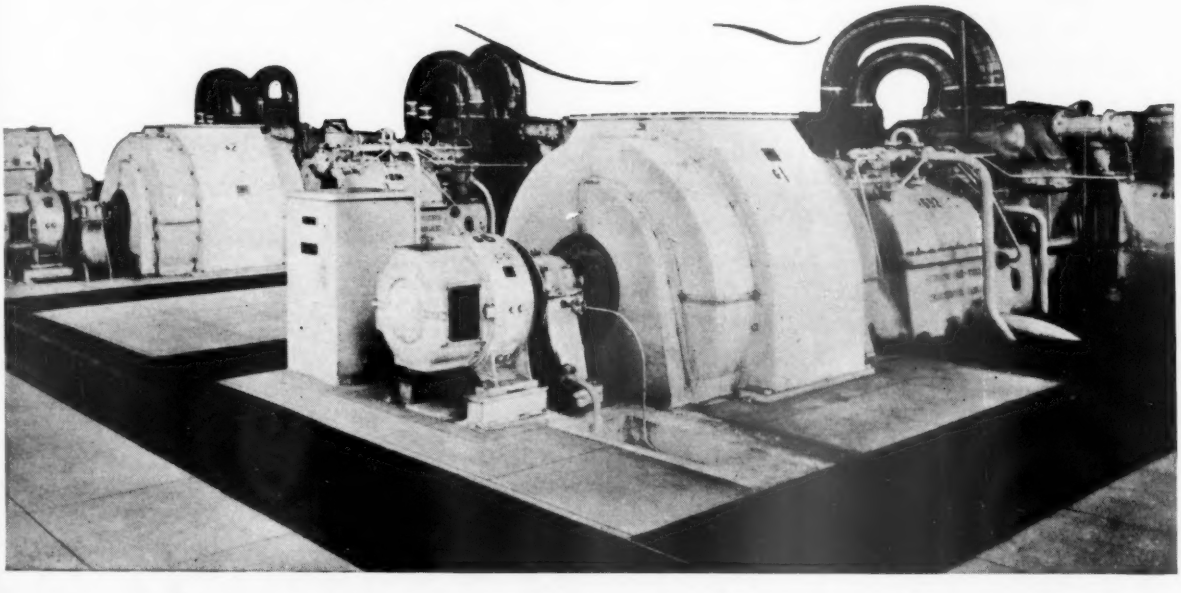

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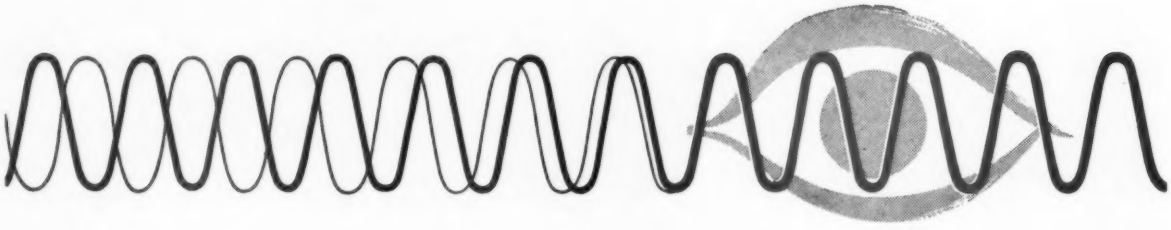

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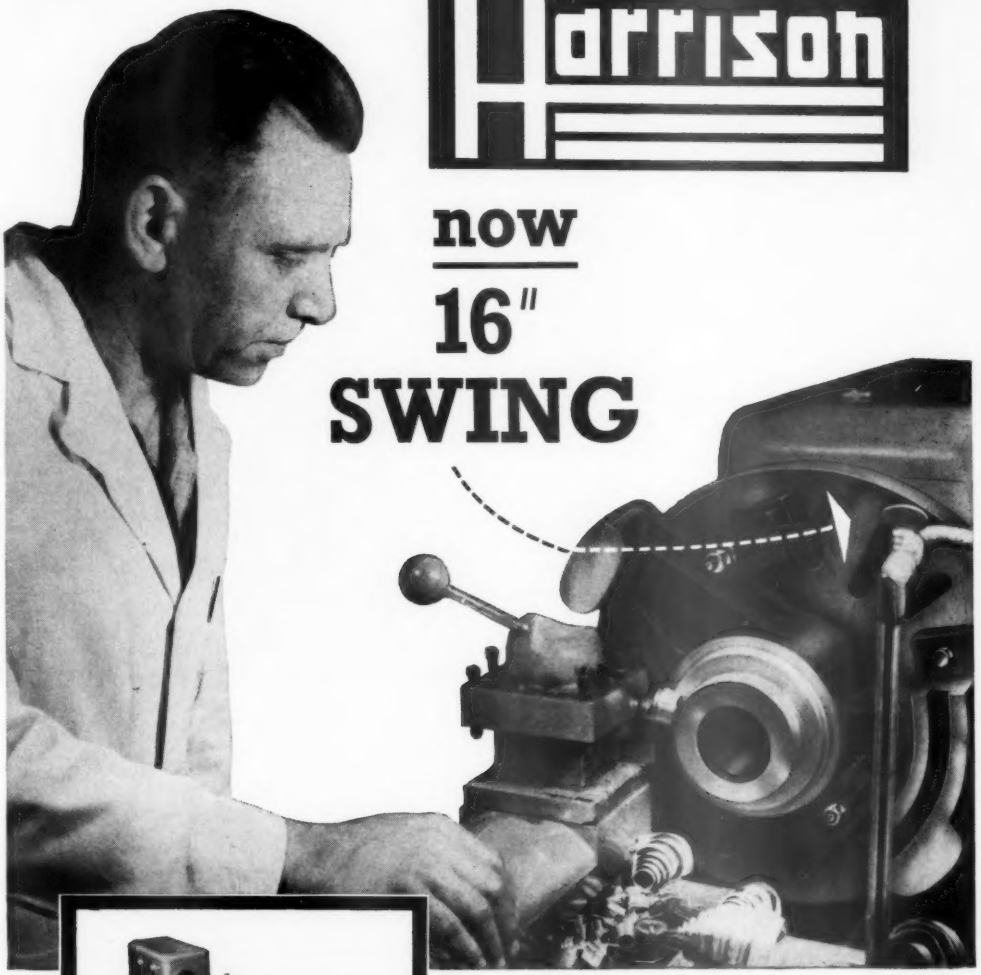

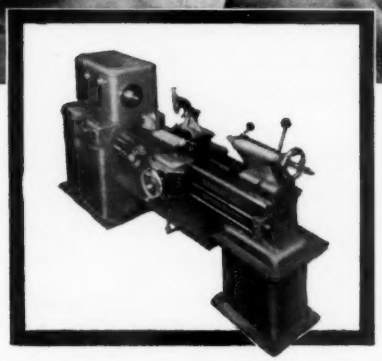

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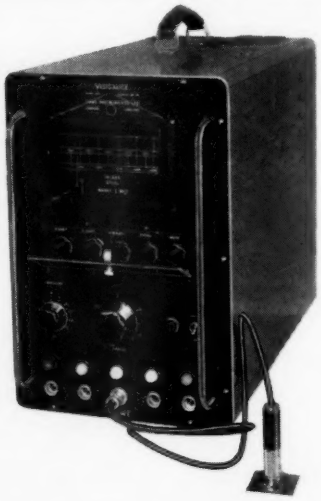

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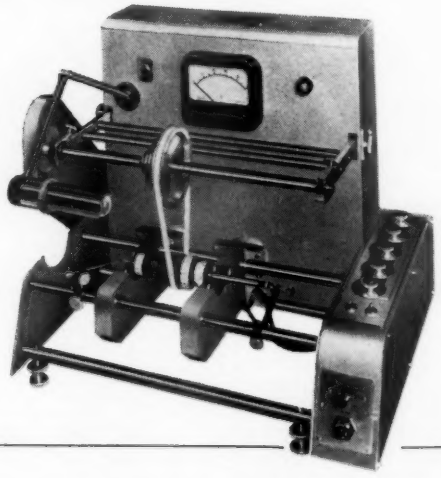

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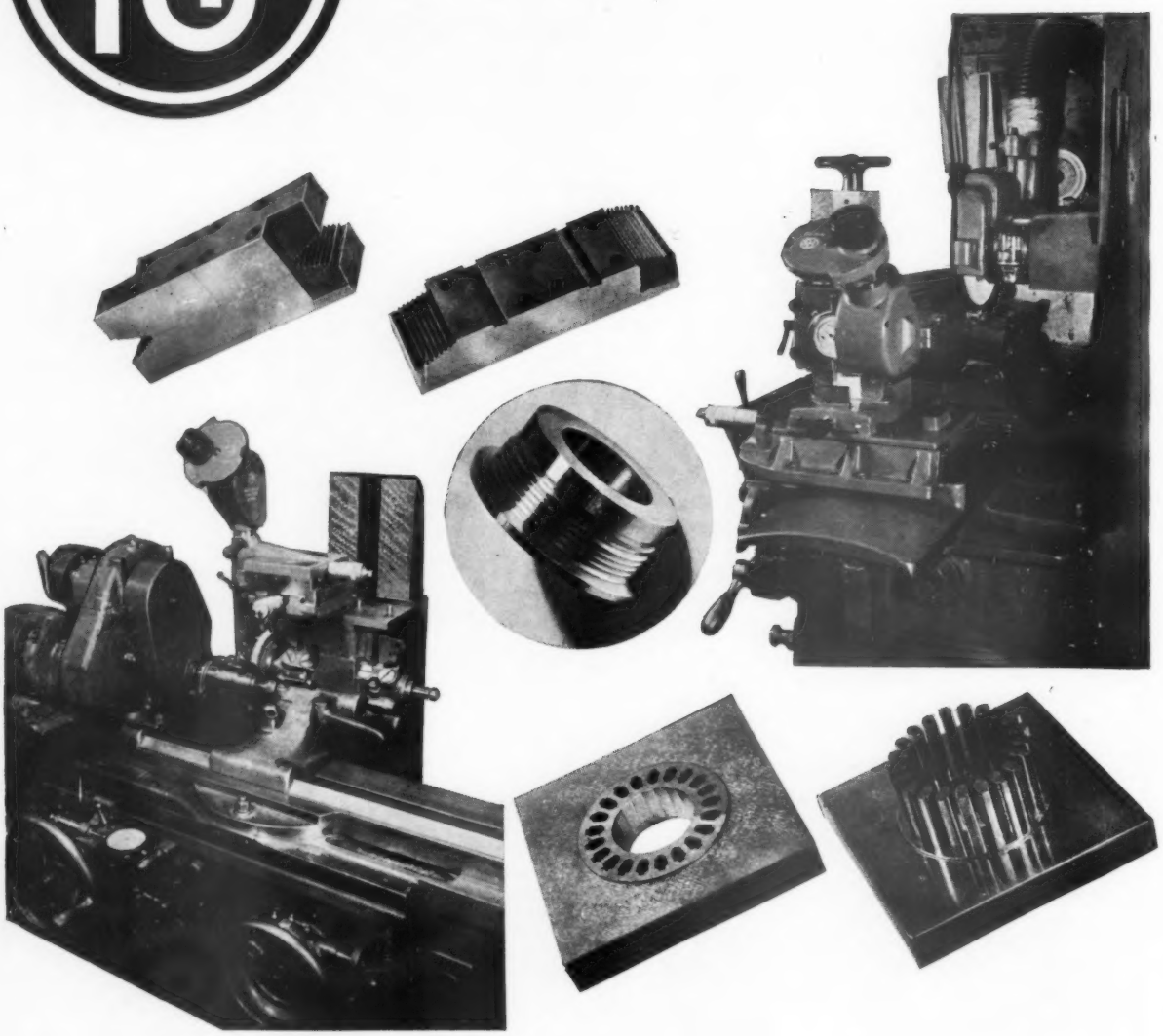

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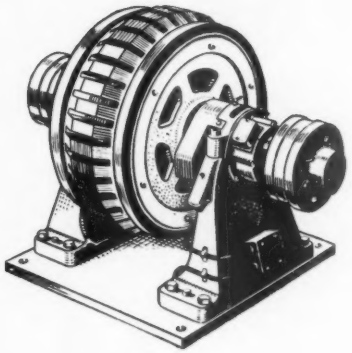

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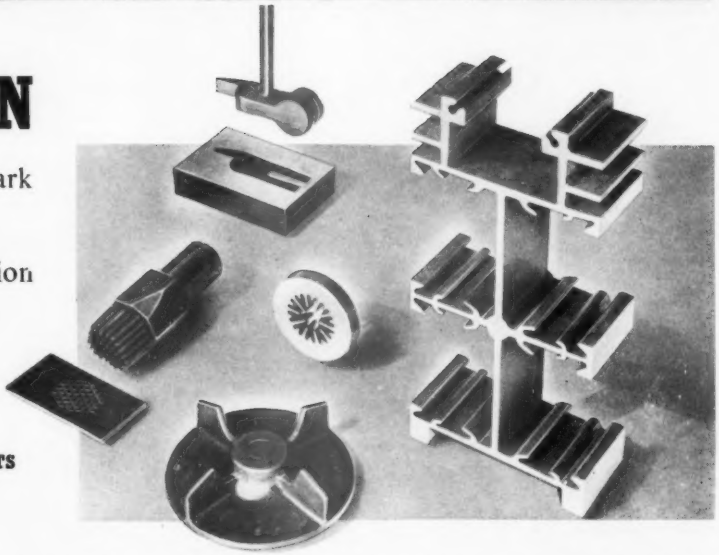

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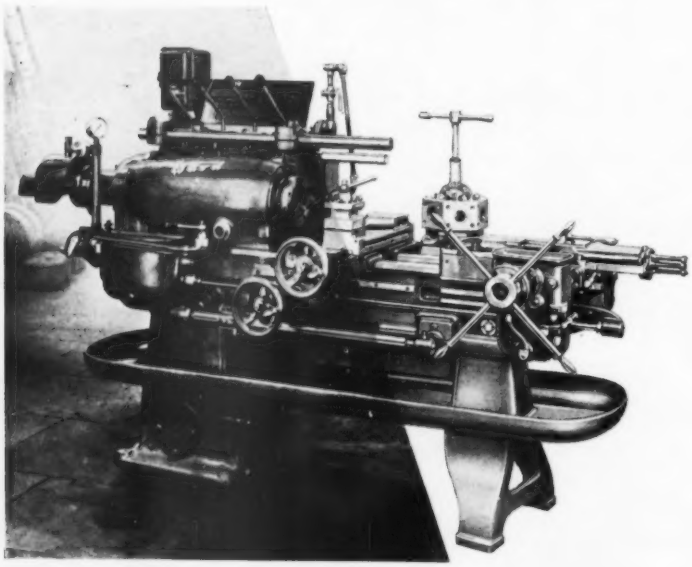

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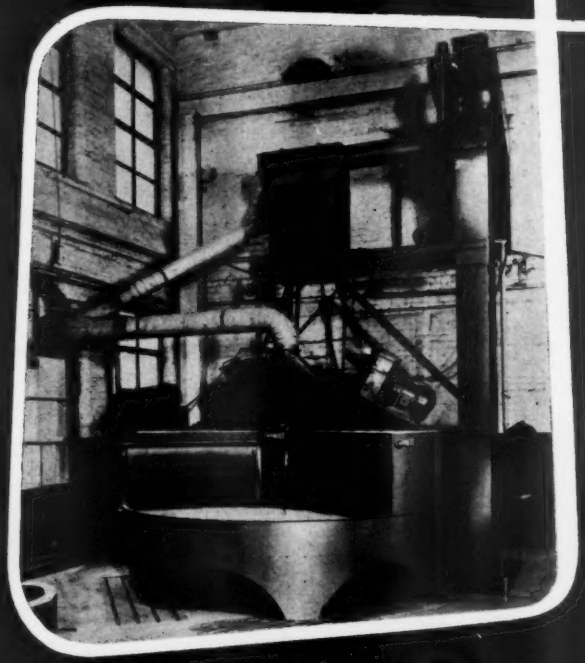

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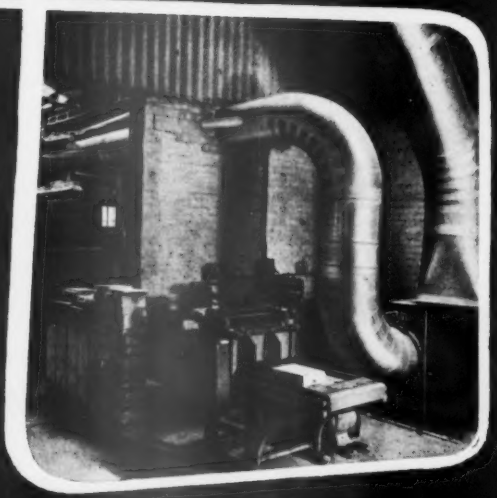

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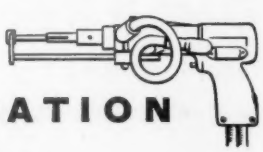

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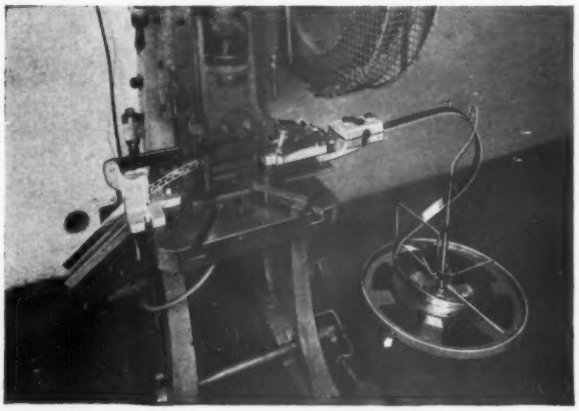

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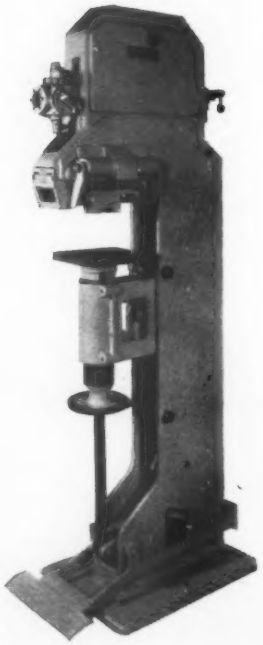

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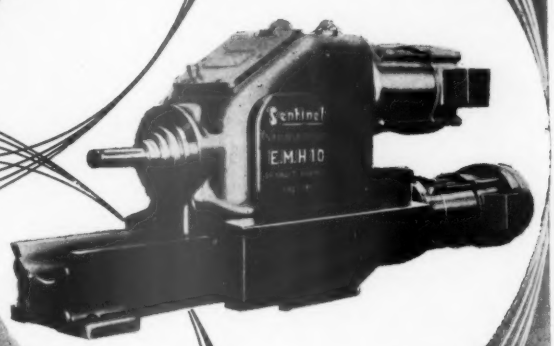

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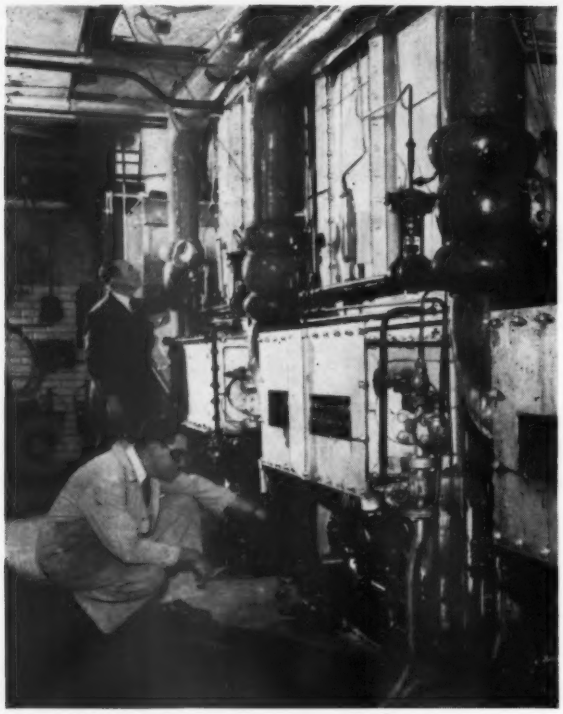

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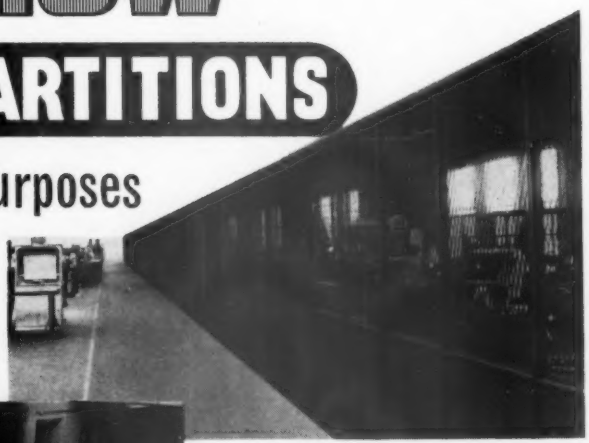

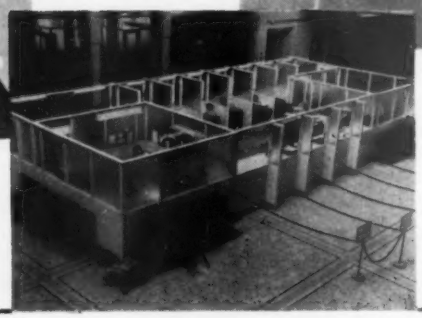

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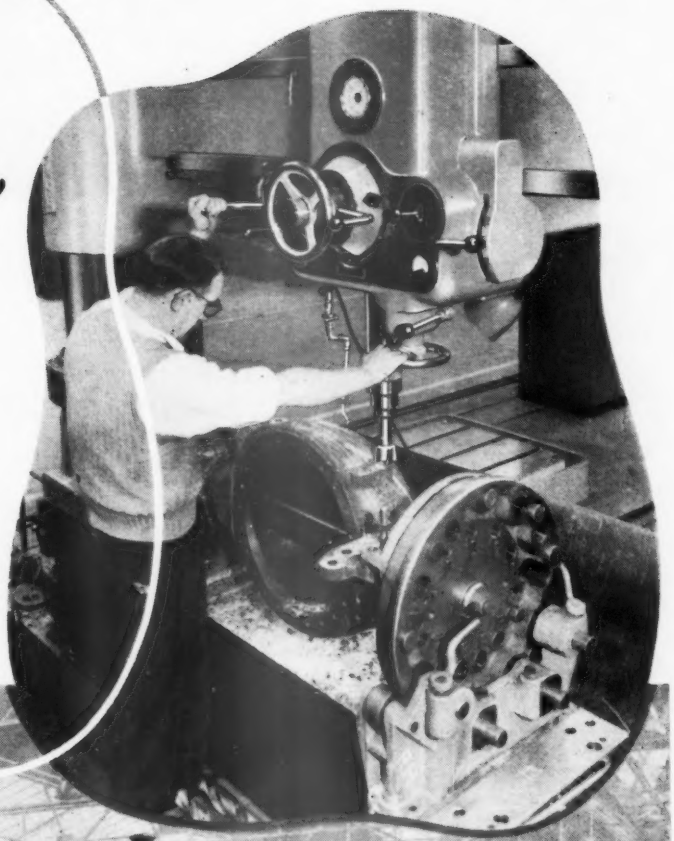

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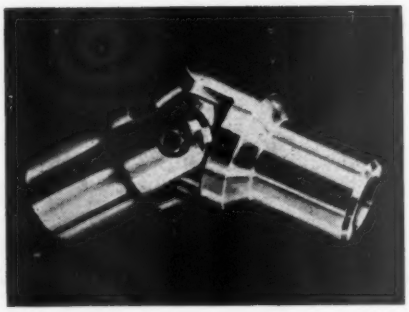

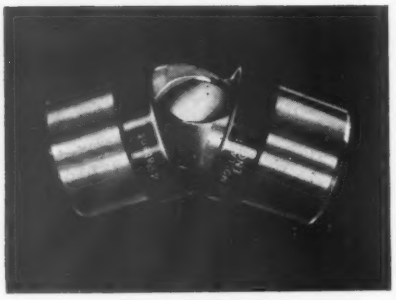

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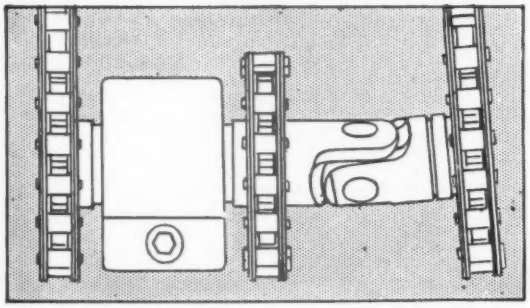

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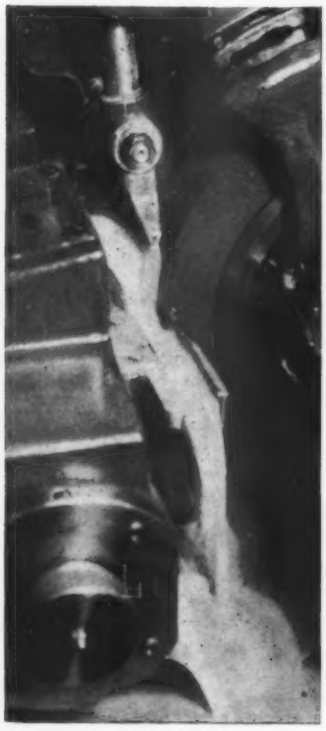

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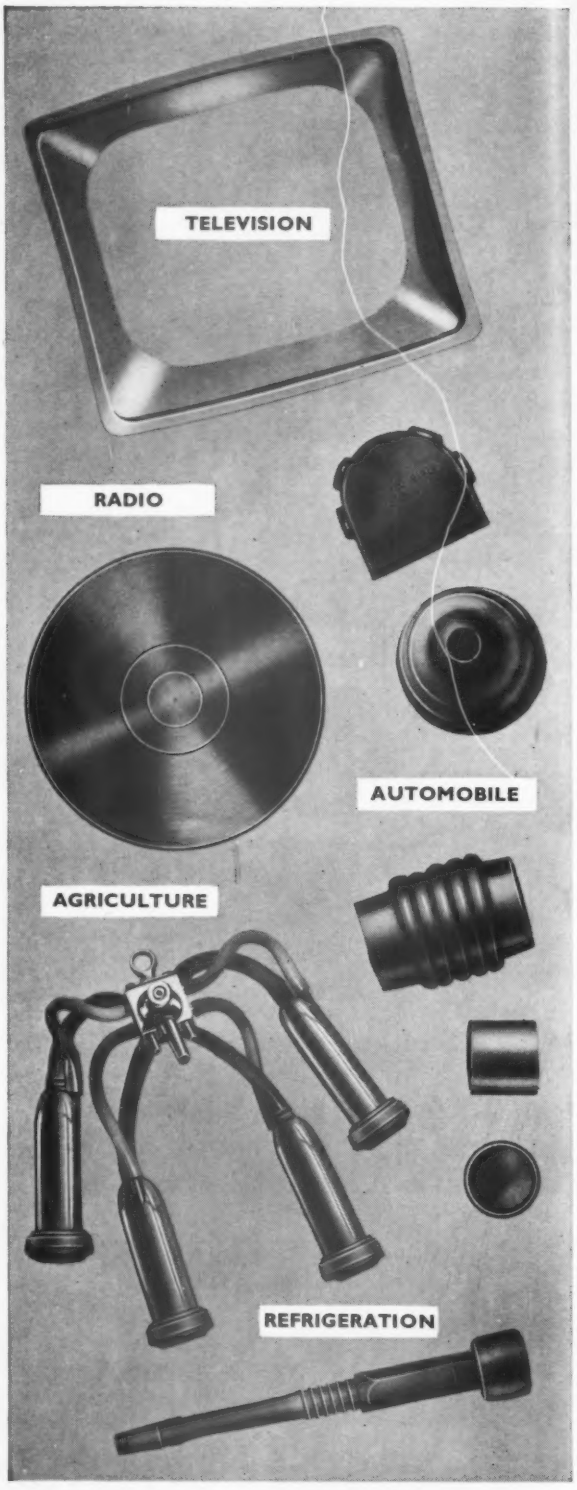

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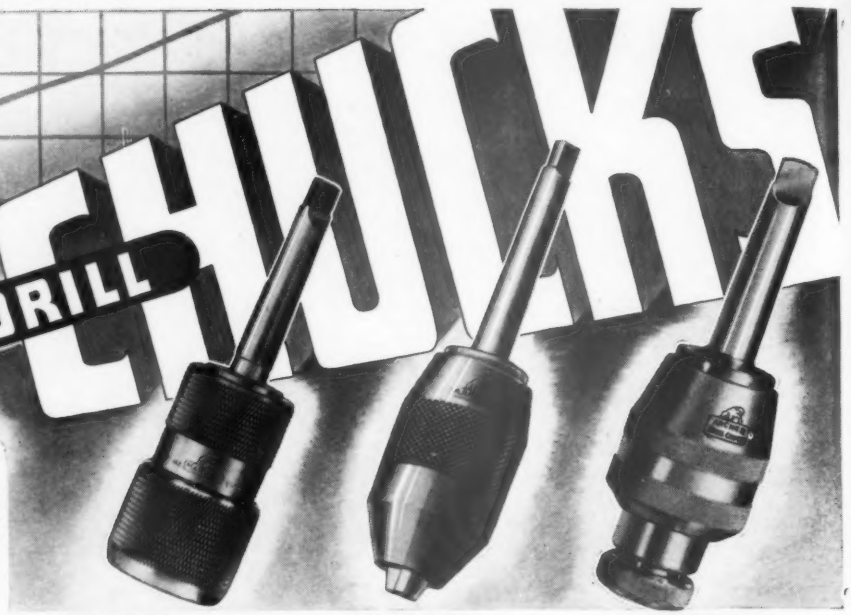

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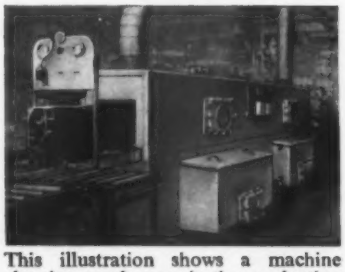

This illustration shows a machine cleaning crank cases in the production line. It is equally capable of cleaning small parts in baskets.

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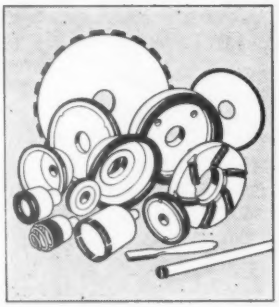

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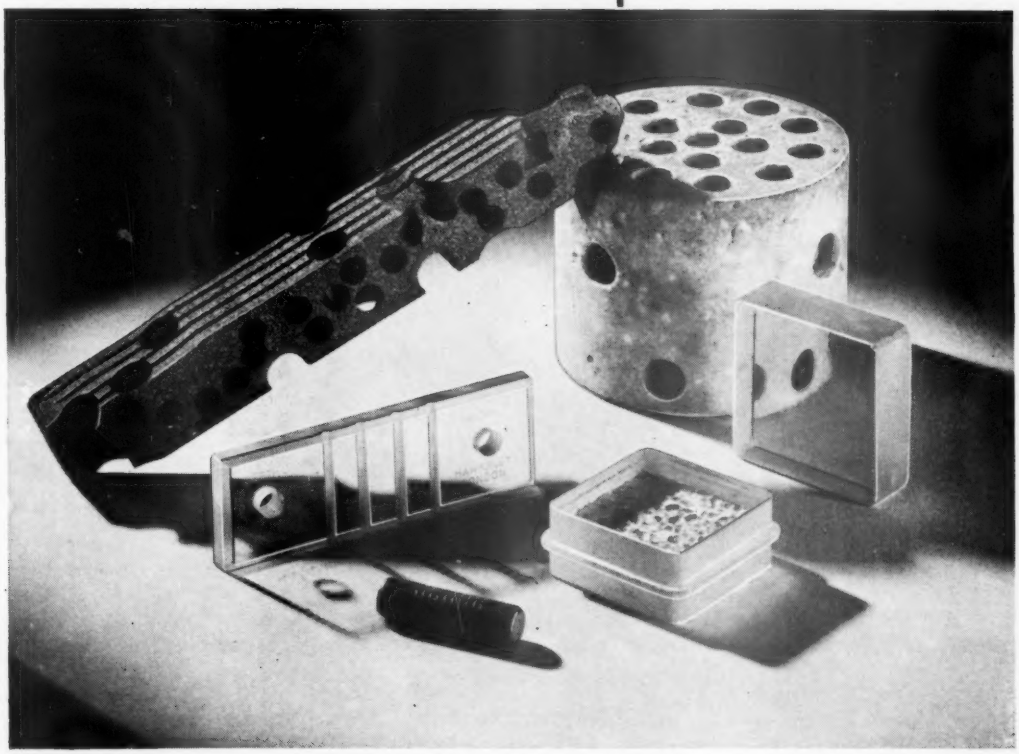

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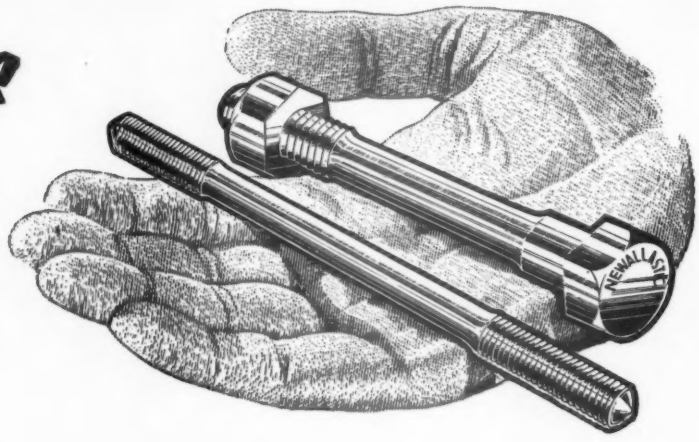

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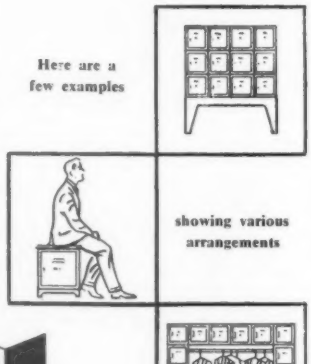
The NEW 'SQUARE DEAL' in Lockers

Rigidly interlocking by patented device, these sturdy steel cube lockers offer endless possibilities for space saving. Stove enamelled in choice of attractive colours. Firmly closing door, fitted with either chromium plated finger pull and ball catch or English 6 lever lock. Extra parts provide for coat hanging and seating. Made in two sizes 12" or 15".

INTERLOCKER

(Patent applied for 13611/54)

Here are a few examples showing various arrangements



AS A WALL FITTING

INTERLOCKER that can be achieved by

HELMSMAN PRODUCTS

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More freedom *in steel casting design if you talk it over with* Lloyds first

The progress of steel casting from an art to a science, allows greater freedom of design and calls for closer co-operation between the engineer designer and Steel Founder. Conference at the drawing board stage often enables the designer to appreciate the wider scope allowed by new casting techniques. Such problems as whether a component is better as a casting or weldment, whether an existing unit would be more efficient as a casting, where to put a boss or a fillet, can be discussed in the light of modern foundry practice.

At F. H. Lloyd & Co. Ltd., where every new foundry technique is tried and tested before adoption, where rule of thumb is replaced by unsurpassed "know how", here the engineer is well advised to talk "design" with Lloyds experienced technicians first.

DIAPHRAGM: *Steam turbine component, weight 600 lbs., dimensions 3′ 6″ diameter × 2½″ deep cast by F. H. Lloyd & Co. Ltd. for English Electric Co. Ltd.*

LLOYDS **Europe's Best Equipped Steel Foundry**

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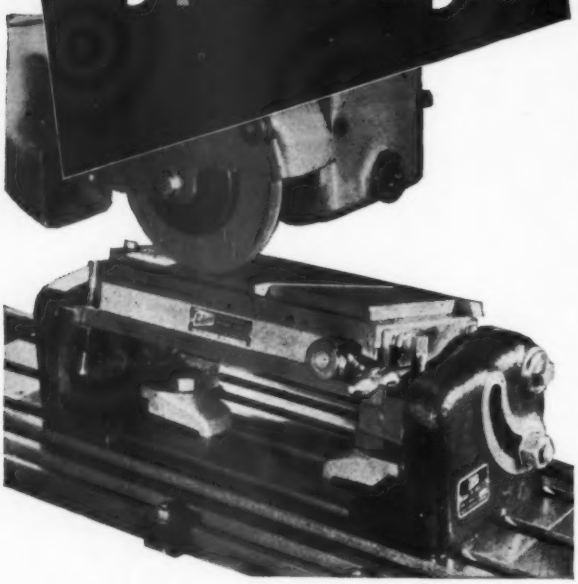

Swivelling Brackets

"Eclipse" Permanent Magnet Chucks, used in conjunction with "Eclipse" Swivelling Brackets, provide a tilting chuck having a full 90° angle of movement. Supplied in matched pairs to ensure complete accuracy and easily assembled with a magnetic chuck which can be modified with a minimum of trouble. Ask for Publication P.M. 140/54.

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PM13

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. . step by step . .

Interruption or reflection of a light beam is the key to many automatic controls.
Elcontrol equipment includes a growing list of photo-electric controllers:—

a **Photoswitches** for counting, conveyor blockage control, intrusion alarm, limit switching, position checking, contents monitoring, etc.
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c **Batch Counters** for packing control, consumption checks.
d **Registration Control** for the control of rotary knives, punches, etc., in relation to the position of a printed pattern, *e.g.*, on wrapping and capping machines.
e **Temperature Limit Control** giving relay operation when a predetermined colour temperature is reached, *e.g.*, in resistance welding, annealing, and heat treatment processes generally (within the range, 800°C.—1,750°C. approx.).

Manufacturers wishing to incorporate electronic controls in their equipment should get in touch with us.

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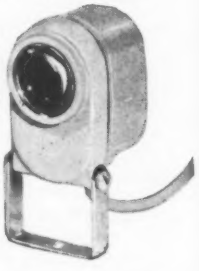
Self-contained photoswitches like this are suitable for very many applications, but if space is limited, a two-unit photoswitch having a separate viewing head containing the photocell may be more convenient.

This small light source is suitable for use with short light spans, e.g., on conveyors. Photoswitch and light source complete from approx. **£23**



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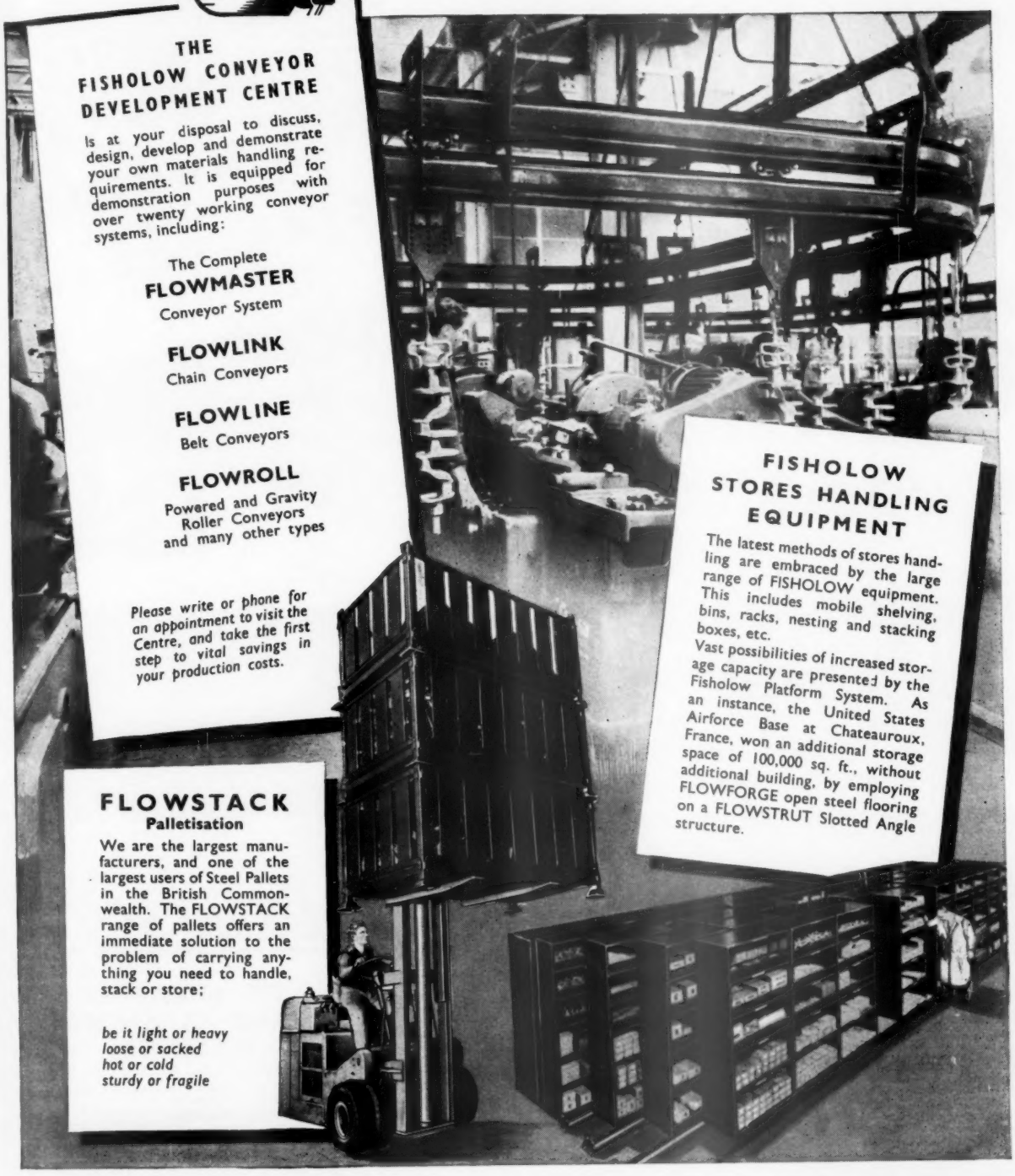
Materials Handling Service to Industry . . .



THE FISHOLOW CONVEYOR DEVELOPMENT CENTRE

Is at your disposal to discuss, design, develop and demonstrate your own materials handling requirements. It is equipped for demonstration purposes with over twenty working conveyor systems, including:

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Conveyor System

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Please write or phone for an appointment to visit the Centre, and take the first step to vital savings in your production costs.

FISHOLOW STORES HANDLING EQUIPMENT

The latest methods of stores handling are embraced by the large range of FISHOLOW equipment. This includes mobile shelving, bins, racks, nesting and stacking boxes, etc.

Vast possibilities of increased storage capacity are presented by the Fisholow Platform System. As an instance, the United States Airforce Base at Chateauroux, France, won an additional storage space of 100,000 sq. ft., without additional building, by employing FLOWFORGE open steel flooring on a FLOWSTRUT Slotted Angle structure.

FLOWSTACK
Palletisation

We are the largest manufacturers, and one of the largest users of Steel Pallets in the British Commonwealth. The FLOWSTACK range of pallets offers an immediate solution to the problem of carrying anything you need to handle, stack or store;

be it light or heavy
loose or sacked
hot or cold
sturdy or fragile

FISHOLOW engineers are ready to advise you on materials handling or storage problems of all kinds.

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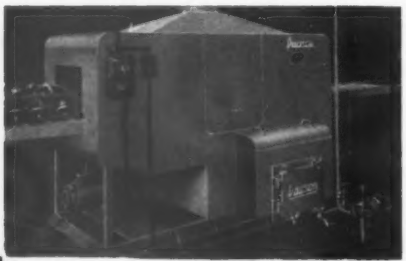
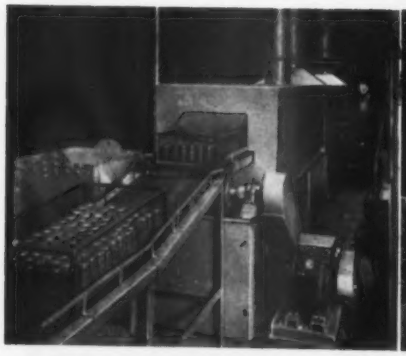
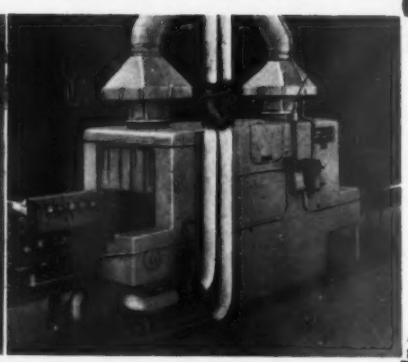
PRIOR TO ASSEMBLY, and BEFORE and AFTER REPAIRS



A 'Junior' type machine supplied to a Midlands Motor Car Works.



Supplied for the washing and drying of Tractor parts. Crank Shafts, Sumps, Pressings, etc.

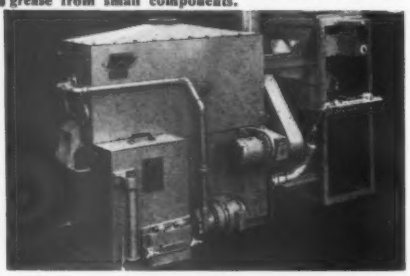


A model 'A' machine, washing parts of motor car engines prior to assembly.

Dawson

DE-GREASING AND CLEANING MACHINES

A Rotary Drum machine for removing swarf and grease from small components.



Dawson Metal Parts cleaning machines are supplied for all branches of the engineering industry. Their chief characteristics are robustness of design, small number of working parts and simplicity of operation. Space only permits the illustration of four of the many types of machines built for quick economical washing and drying of Metal Parts.

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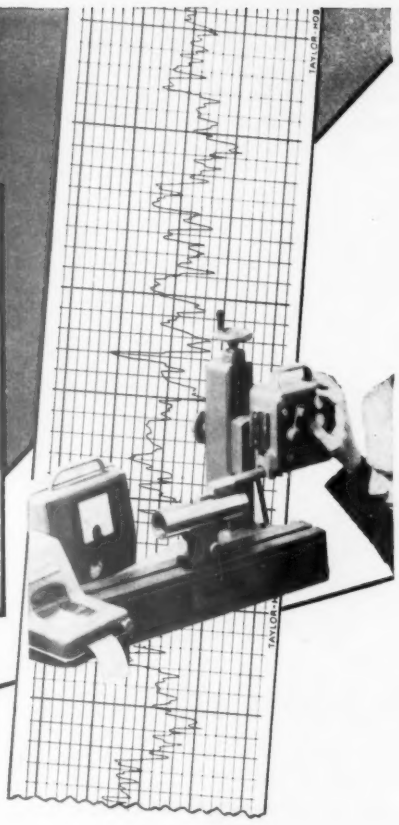
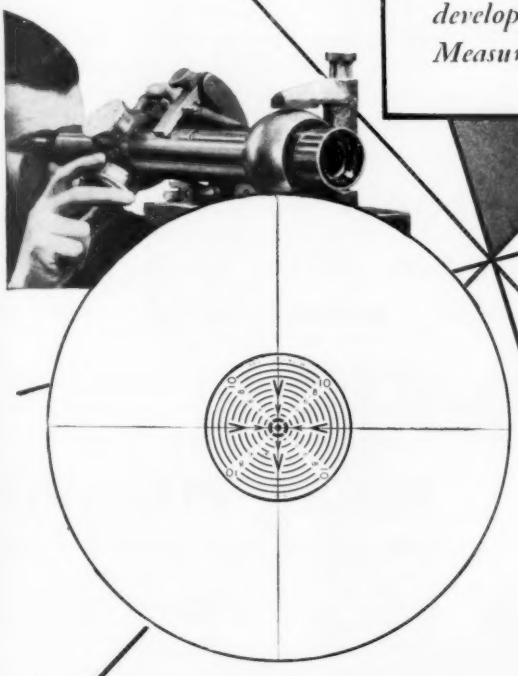
TAYLOR-HOBSON

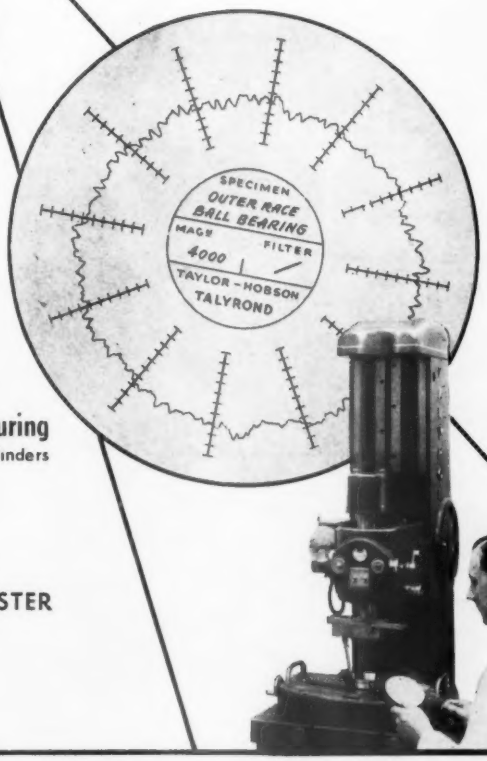
A Company founded on the basic need for Precision, and never since surpassed in the design and development of Measuring Instruments



Model 3 'TALYSURF'
for Surface Measurement



'Micro' ALIGNMENT TELESCOPE
Optical Tooling for large Jig Building



'TALYROND' Roundness Measuring
for Balls, Rollers, Races, Pistons and Cylinders

TAYLOR, TAYLOR & HOBSON LTD., LEICESTER

A Member of
RANK PRECISION INDUSTRIES LTD

This is an example of All-Welded Machine Bed Plates manufactured by this Company. The photograph shows how well the complications of modern machine practice can be overcome by this modern method resulting in great economies.

We can profile cut any shape in mild steel from ¼" to 6" in thickness. Our products are clean cut and necessitate the minimum of machining and finishing. They make for large economies in reducing the number of operations. Send your enquiries to:-

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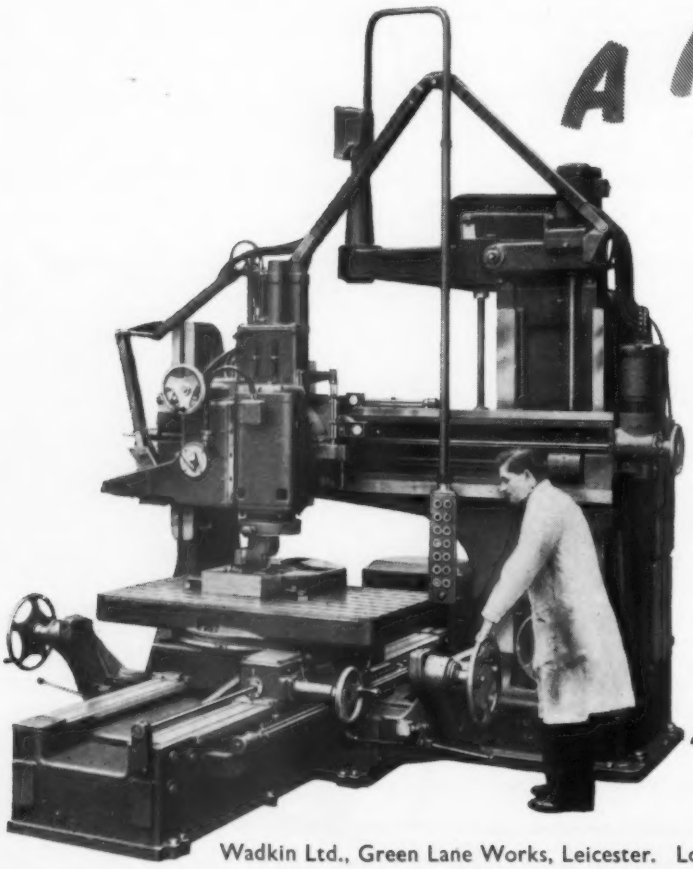

A NEW

Milling Machine

with speeds from 30-3000 r.p.m.

This is an entirely new development in machine tools, designed to fill the need for a fast versatile Miller capable of intricate milling operations on large components in non-ferrous and ferrous metals. Primarily designed for the economical machining of complicated metal patterns it has an equally useful application in the Machine Shops for a big variety of face milling, profi'e milling, contouring for die sinking etc., Spindle speeds range from 500 to 3000 r.p.m. and by the addition of cap heads speed ranges as low as 30 to 180 r.p.m. are available.

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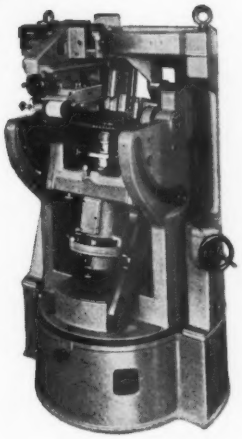
Wadkin Ltd., Green Lane Works, Leicester. London Office: Brookfield House, 62 Brook St., W.1

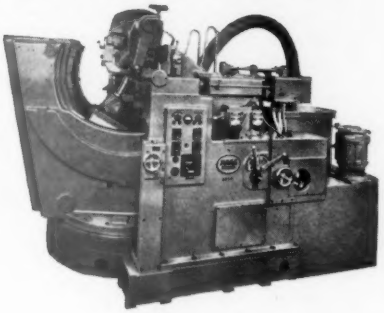
MAAG

GEAR CUTTING · GRINDING · TESTING

Equipment of the finest standards —designed to ensure economical high-rate production to the extremes of accuracy.

The MAAG range is most complete. These machines are representative only, but we shall be pleased to submit detailed proposals based on your production requirements.

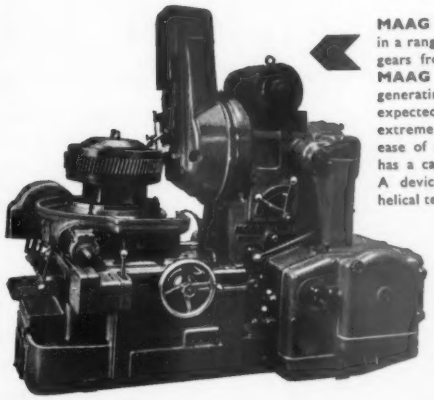




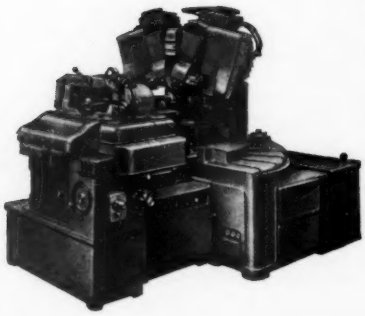
MAAG Bevel Gear Testing Machine, KP-42, is a companion to the Type KS-42 Bevel Gear Grinding Machine, right. This machine records tooth alignment, tooth thickness, tooth profile and surface finish of *bevel* gears up to 16.5 in. dia. It will measure the cone angle and the generating angle as well as the lateral displacement in the case of *oblique bevel* gears. The error magnification is adjustable between 100 : 1 and 1,000 : 1.

MAAG Bevel Gear Grinding Machine, Type KS-42, is a recent addition to the **MAAG** range for precision grinding involute tooth flanks and tooth gullets of straight-toothed *bevel* gears up to 16.5 in. dia. at a ratio of 1:8 (smaller dias. at lower ratios). This machine operates on the generating principle and is extremely accurate. Equally economical for individual gears or large batches.

MAAG Gear Testing Machine, PH-60, inspects, measures and records tooth profile, tooth alignment, helix angle, concentricity and surface finish of tooth flanks. Capacity 23 in. dia. Can be adapted for spur and helical *internal* gears. Other **MAAG** gear testing and measuring instruments are made in various types and sizes for checking pitch, profile, centre distance and concentricity with a precision of 0.00004 in.



MAAG Gear Cutting Machines are made in a range of sizes for cutting spur and helical gears from 0.8 in. to 200 in. dia. Like all **MAAG** machines, they operate on the generating system and possess all the qualities expected of modern machines including extreme accuracy, maximum efficiency and ease of operation. Type SH-75, illustrated, has a capacity from 1.2 in. to 29.5 in. dia. A device for cutting *internal* straight and helical teeth and racks can be supplied.



MAAG Spur and Helical Gear Grinding Machines are made in a range of sizes up to 140 in. dia. capacity. Type HSS-10 illustrated, is a high production machine for small gears up to 4.7 in. dia. This high-speed machine features infinitely variable speeds, rapid grinding times and easy change-over. Its accuracy is easily within the fine limits required for high class gears, i.e., pitch and profile errors do not exceed 0.00008 to 0.00016 in.

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GRIFFITHS

Sole Agents in Great Britain:

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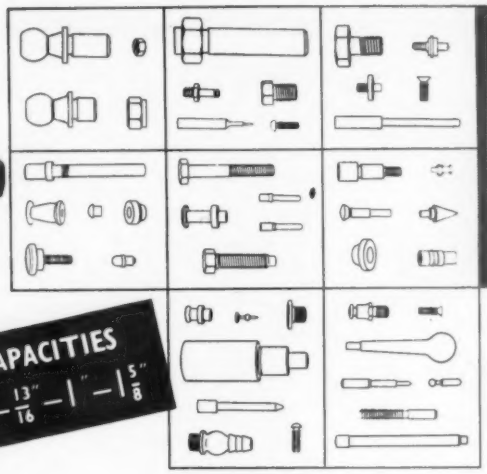
Model A25 with built-in thread cutting attachment



TRAUB

Single Spindle AUTOMATICS

CAPACITIES

$\frac{19}{32}$" — $\frac{13}{16}$" — 1" — 1$\frac{5}{8}$"

Model A.15L with longitudinal turning attachment

- Simple set up.
- Economical on short and long runs.
- Reduced floor space.
- Standard collets.
- Bed guides hardened and ground.
- Accurate and rigid.

EXCLUSIVE DISTRIBUTORS IN THE UNITED KINGDOM

The illustrations show a few examples of the wide range of components which can be manufactured on the TRAUB.

Please ask for demonstration and quotation on these precision but low priced automatics.

EARLY DELIVERY

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ELGAR Machine Tool Company Limited

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PATENT CALIPER GAUGE MODEL 52

Each month one of the seven main advantages of this fine precision instrument will be described.

★● Many different gauging positions can be obtained.

- The anvils are set so that they do not roll.
- All shearing action is eliminated.
- Particularly suitable for gauging shouldered work.
- Can be used for either left or right hand threads.
- Particularly suitable for the gauging of acme forms of thread.
- Can be supplied for "GO" only, or "NOT GO" only, or both "GO" & "NOT GO" combined.

NOTE THIS MONTH'S IMPORTANT FEATURE

★ **MANY DIFFERENT GAUGING POSITIONS CAN BE OBTAINED**

Both GO and NOT GO Jaws are adjustable and, as the gauging surfaces are radial and are eccentrically mounted, numerous gauging positions can be obtained and the necessity for re-grinding eliminated. The length of life is, therefore, greatly prolonged.

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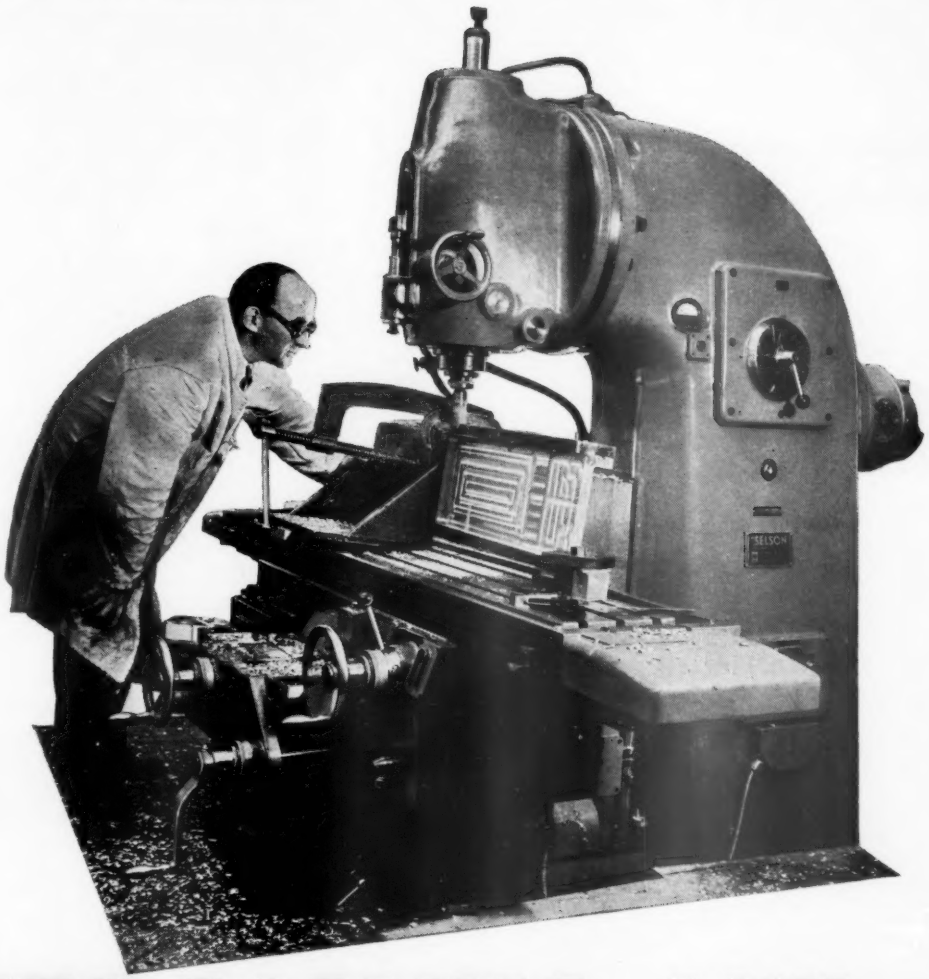

ZBROJOVKA Millers

Complete rigidity at high machining speeds

The illustration shows a Zbrojovka Miller FA5V machining an aircraft main wing spar web from solid billet. It is installed in the Works of Messrs. C. J. C. Developments (Portsmouth) Ltd., Farlington, Portsmouth, by whose courtesy this picture is published.

Brief Specifications of Horizontal, Universal and Vertical Millers

Sizes:	No. 2	No. 3	No. 4	No. 5
Working surface of table (approx.)	40″x 8″	50″x 10″	64″x 12″	80″x 16″
Power longitudinal travel (approx.)	25″	32″	40″	50″
Power cross travel (approx.)	8″	9″	12″	16″
Spindle speeds ...	63-2800	45-2000	32-1400	18-1400

Sole agents

Selson MACHINE TOOLS

Early delivery

The Selson Machine Tool Co. Ltd

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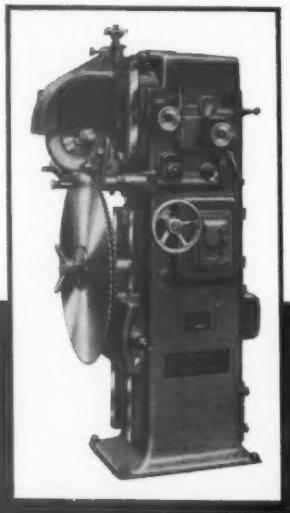
Telephone: Elgar 4000 (10 lines) Telegrams: Selsomachi, London

THE 600 GROUP

557/SMT 170

RUSSELL

metal sawing machines



The Russell Hydrofeed range includes :

• Straight and angular cutting models • Automatics • Verticals • Special Billet cutting models

Patented Features :

• Interlocking Vices — for easier setting • Hydraulic Circuit — for efficient cutting

a **SAW SHARPENING MACHINE** *Capacity 11" to 48" blades*

b **'HYDROFEED' COLD SAWING MACHINE** *Automatic bar feed*

S. RUSSELL & SONS LIMITED
LEICESTER, ENGLAND

Backed by over 40 years' specialised experience

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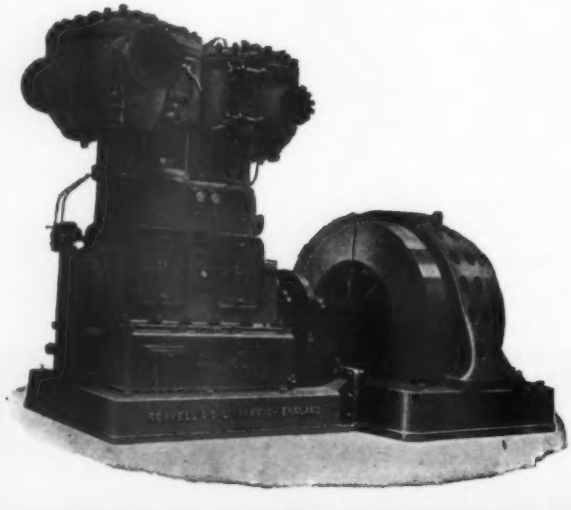
AIR COMPRESSORS

DO NOT FORGET THAT WE HAVE

A COMPLETE RANGE TO SUIT ALL DUTIES

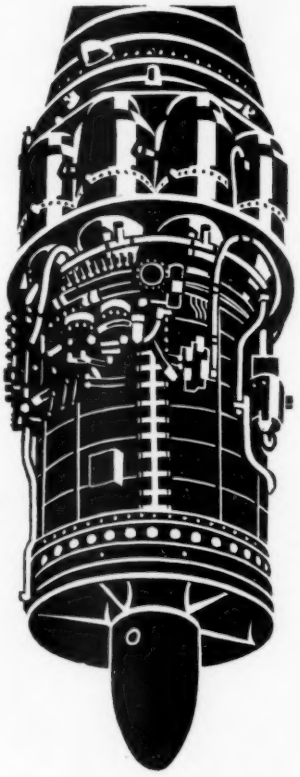


Whatever it is you need—large or small capacity—high or low pressure—we can supply the best machine for the purpose, and our fifty years of specialised experience are at your service.

REAVELL & CO. LTD.

IPSWICH

Telegrams: Reavell, Ipswich **Telephone Nos.: 2124-5**



from jets

to jelly babies

Already, in almost every industry, PNEUTOMATION — Lang Pneumatic Control Gear — is greatly increasing productivity. A look into any factory reveals instances in which an automatic means of operation could reduce costs, boost output, increase accuracy and save human effort and time. Lang Pneumatic Control Gear provides materials movement between process points, and takes care of sequence operations on machine tools and process plant, eliminating errors, maintaining greater accuracy and effecting marked economies.

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Jet engines · Turbo-prop Engines · Automobiles
Milk · Money · Bicycles · Shoes · Boxes
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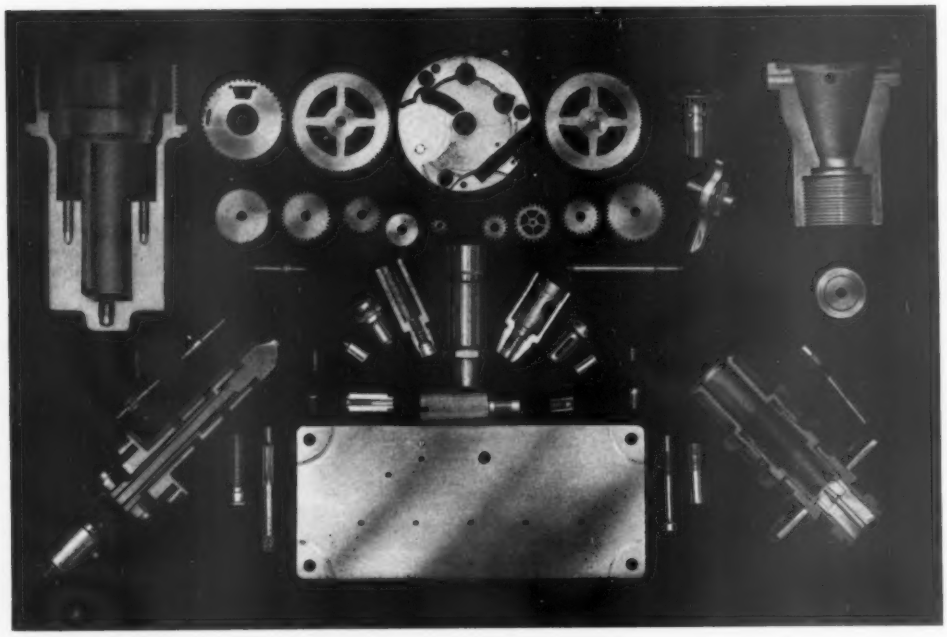
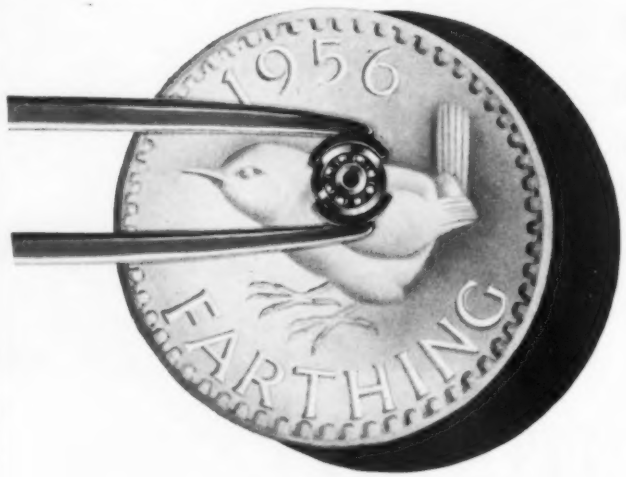
Grams "BRAYACS LEEDS 2"



MASS PRODUCTION OF PRECISION COMPONENTS & ASSEMBLIES TO FINE TOLERANCES BY NON-SELECTIVE METHODS



WE CAN ONLY SHOW BY COMPARISON

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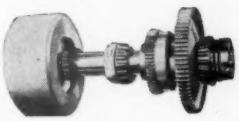

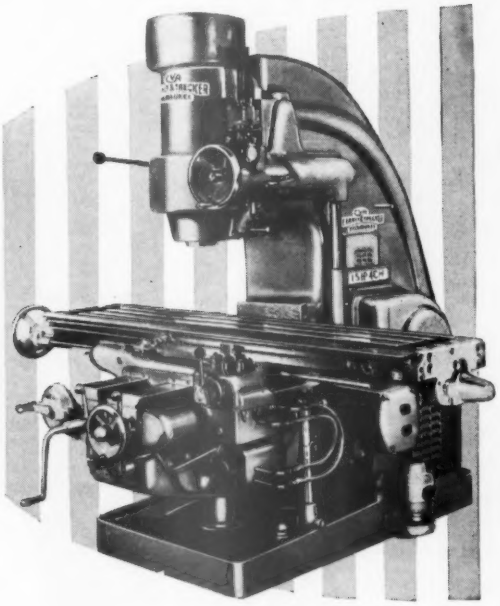

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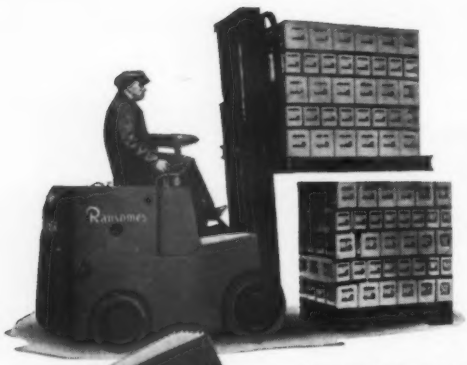

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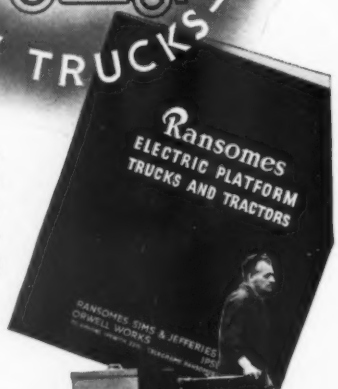

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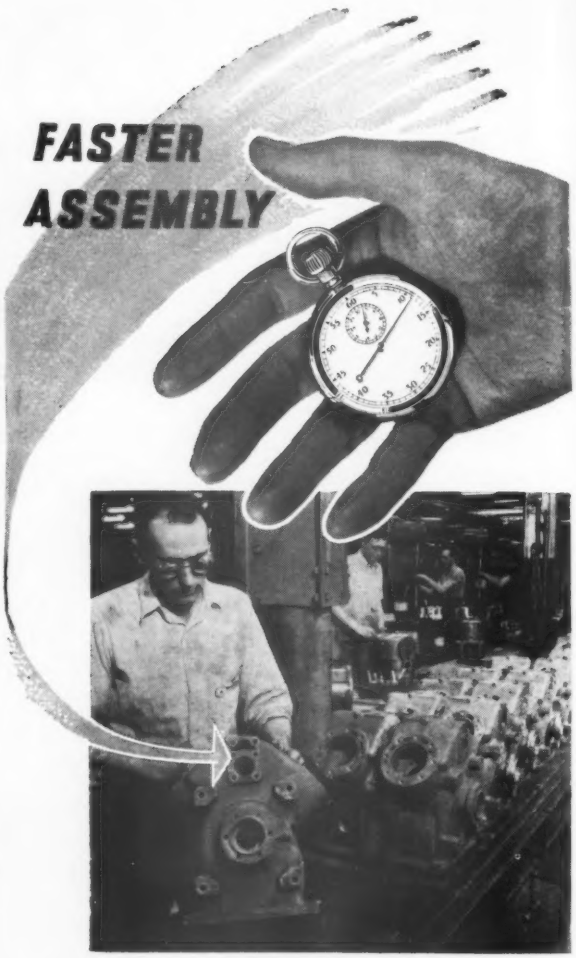

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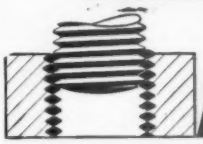

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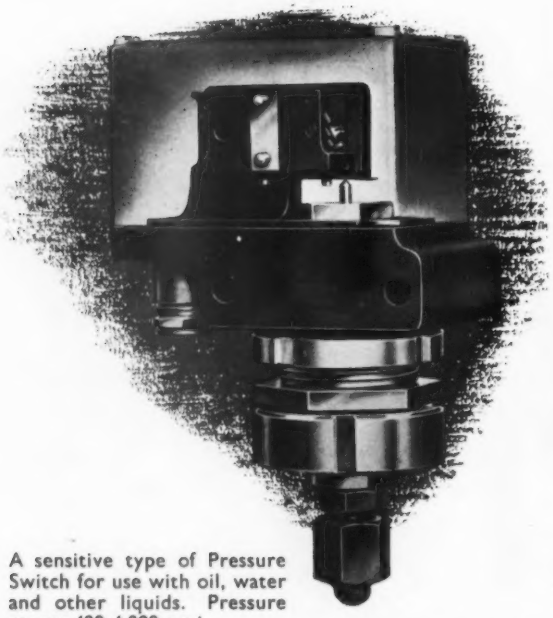

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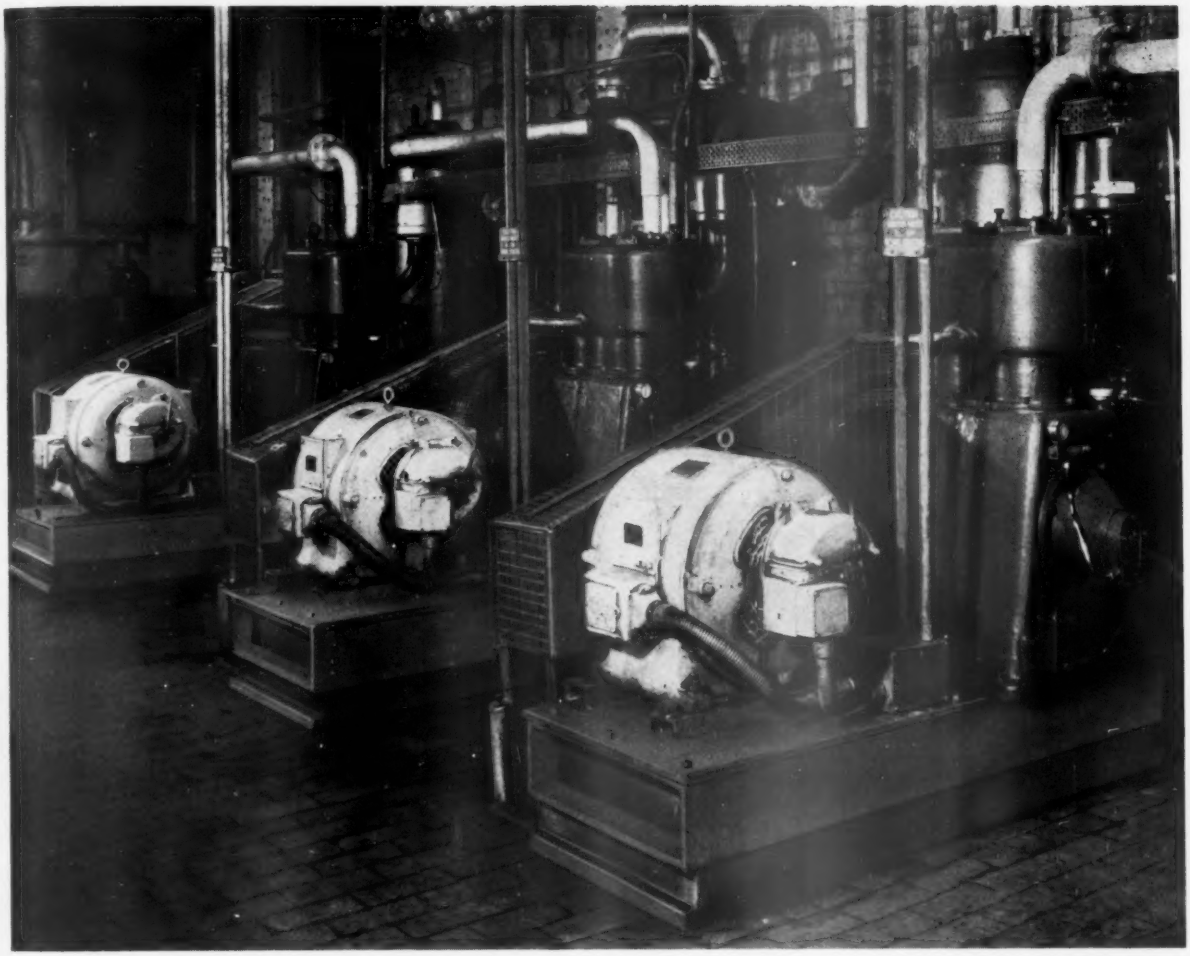

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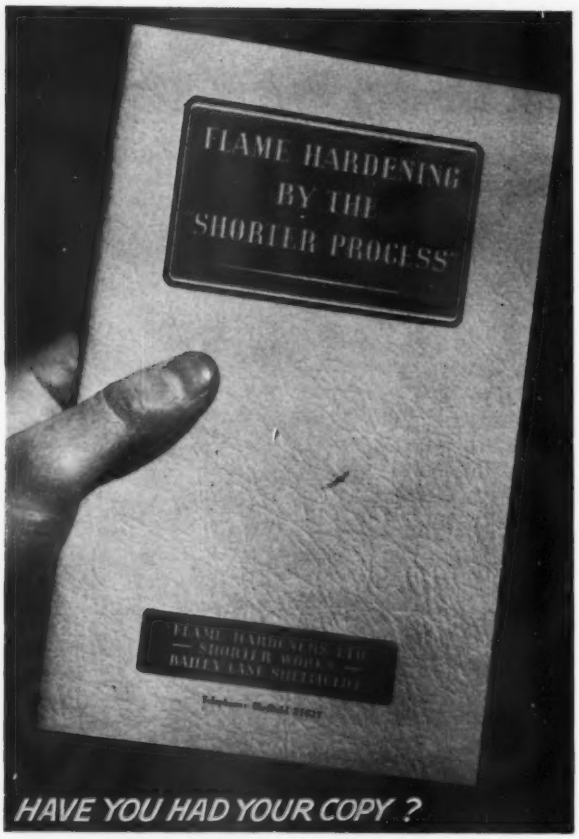

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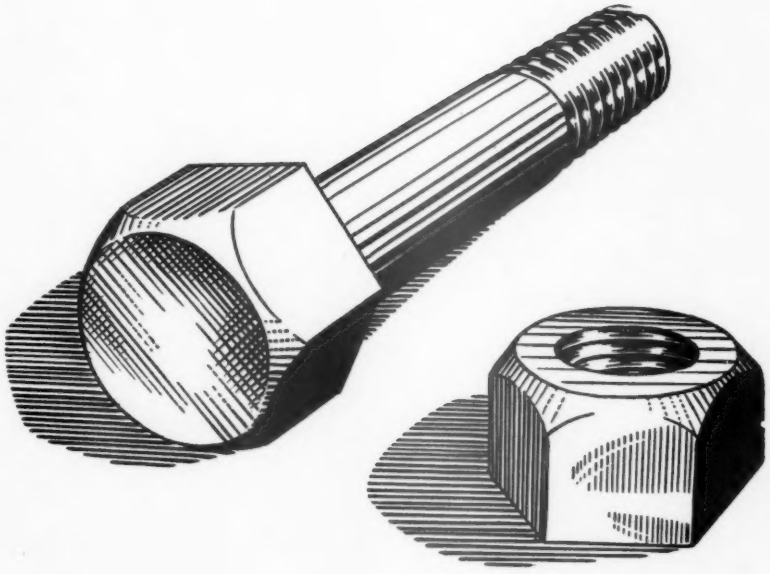

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